A Primer of Engraving and Printing

A Primer of Engraving and Printing

Including Composition, Electrotyping,

Paper, Presses and Ink

By

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Acknowledgment

On August 1st, 1896, at 7:30 A. M. I reported to the superintendent of a New York City printing plant, to begin employment and to learn the printing business. It was my first job, and my introduction to the graphic arts.

From that day to this, I have worked with and have been guided by expert craftsmen; men and women, young and old, many of whom were masters of specialized knowledge in their respective fields. Some were famous; others remained anonymous; but all of them gave priceless help and gave it ungrudgingly.

It was inevitable that much of this information should become stored away, to be called upon from time to time as occasion demanded.

In this little book I have drawn freely from that mental storehouse, but as the reader absorbs the facts I hope he will see, by a sort of mental television, the people who made the contents of that storehouse possible.

If he does this, he can claim technical guidance from some of the most skilled artisans the graphic arts have known.

And Thanks

To: Ed Gottschall, Jack McKenna, George Carl, Walter Huxley, Frank Hess, John O'Rourke, Ellsworth Geist, George Welp, Lucia Howe, Kenneth Groesbeck, and my associates at The Beck Engraving Company, I extend my thanks for many helpful suggestions.

Harry A. Groesbeck, Jr.

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The Art of Printing

and the Three Processes

I

The Art of Printing

The art of printing is based on a very simple principle: ink the tip of your finger, press it on a piece of white paper, and you will make a fingerprint. It will be a printed image of the pattern of lines on your finger.

Printing can be as simple as making a fingerprint; it can be as complex as producing five million copies of a hundred page illustrated magazine; or it can be in between these two extremes.

But simple or complex, and regardless of the processes of printing involved, there must always be something to print from; something to serve as a pattern for the thing to be printed. You cannot make a fingerprint without a finger tip, nor can anything else be printed with printer's ink on paper, unless there are forms of type; engraved plates, blocks or cylinders; or something to print from.

Printing on paper with ink is not an independent process; it is joined interdependently with the arts of typesetting and engraving, or some other form of platemaking; and these, in turn, have no value in the field of graphic arts unless they are used for printing.

Printing plates and printing presses are like records and phonographs. Either is useless without the other, but in the graphic arts the combination plays to the eye, rather than to the ear.

Printing with presses is a mechanical process which enables many impressions to be made from printing plates, quickly, properly and economically.

Typesetting, engraving and platemaking are not mechanical in the same sense that printing is. They are processes and methods for making patterns for printing. These can be used by the printing presses to reproduce words, designs or pictures in small or large quantities. They are extremely flexible and versatile, for they make it possible to put in print any combination of words, characters and figures in any language; or to reproduce any design, picture or other graphic form, in black and white or in color.

This flexibility and versatility makes them extremely sensitive to the touch of the guiding hand. For better or for worse, they need to be pretty thoroughly understood before any attempt is made to use them.

The Three Printing Processes

There are three basic methods of printing and each has its own peculiar requirements as to the way its printing plates are made.

These three printing methods are:

Letterpress
Lithography
Gravure

Letterpress

Letterpress printing is always done from "relief" printing surfaces. A relief printing surface is like the lines on the finger tip, like a rubber stamp, or like type.

When a printing surface is in relief, it is because the spaces between the printing elements are lower and consequently do not print (even though they may have ink in them) because they do not come into contact with the paper.

There are numerous methods for lowering the non-printing areas of relief printing plates, but the principles most generally used are: either to cut or engrave them by hand or machine, or to etch them.

Each of these is a form of "engraving."

When photography is employed, it affixes the image to be engraved to the surface of a sheet of metal *preparatory* to etching, then the process of platemaking is called "photoengraving." This is the process which makes "reproduction" possible. Photography copies the subject to be reproduced; it does so accurately, and in any desired size. A special photographic printing method applies the image to the surface of the metal plate to be etched, and when this print has been completed it acts as an acidproof protective covering on all *printing* areas of the image. But because of the way this part of the process works, all of the *non*-printing areas, such as the spaces between the lines, dots or other elements of the image, are left with no protective covering whatsoever. Consequently, the etching acid will bite into them and give them enough depth to prevent contact with the paper when the higher areas are inked and printed. Hand or machine engraving can be used to supplement the etching method, or vice versa.

Lithography

"Lithography" is the term most generally used to designate the second method of printing. The term is an inheritance from the early days when all lithography was done from smooth, flat stone slabs; the word *lithos* means stone. In modern practice, thin metal sheets are nearly always used.

The original lithographic principle depends upon the

fact that grease and water have no affinity for each other. In this kind of lithographic platemaking, the image eventually to be printed is affixed to the surface of the thin metal plate (or to the stone if that is being used) in the form of a thin film of greasy ink. In other words, all printing elements have a greasy surface. The spaces between are dampened with water moisture. The ink used in this process for printing is also somewhat greasy and, when it is applied to the finished printing form, it sticks to the grease image but is rejected by the water. The non-printing areas of a lithographic plate do not print because there is no ink on them; they have been dampened with water and consequently refuse to accept ink. The water moisture on the plate, as well as the ink, must be replenished after each impression. Lithographic presses therefore have two sets of rollers, one for the ink and the other for water.

The grease image on the printing plates can be hand drawn, it can be applied photographically, or it can be made by "transfers" from a master plate or stone.

When lithographic stones are used, the process is true lithography. If metal plates replace the stones, the process becomes, technically, "planography," but the original descriptive name "lithography" still persists.

Most modern lithography is done by what is called the "offset" process. The original thin metal plate is wrapped around a plate cylinder on the press and the printed impression from this is made on a rubber blanket wrapped around another cylinder. This blanket, in turn, makes the contact with the paper and the ink image on the rubber "offsets" onto the paper.

The grease and moisture features of lithography are also used in the photogelatin process which is known as "collotype," but glycerine is used instead of water and

the moisture required is taken from the air and absorbed by the glycerine.

There are also several bi-metallic methods in use and in process of development. These include zinc, copper, aluminum, chromium and stainless steel. Some use ungrained metal, others use grained surfaces. In principle, one metal is ink receptive and the other rejects the ink and accepts water. The grease feature is therefore reduced or eliminated.

Gravure

The third printing method, identified by the general term "gravure," includes a lot of ancient, highly creative processes such as steel engravings, copperplate etchings, aquatints, mezzotints and dry points. The first use of photography in connection with these was "photogravure" and the high-speed modern development of this process is sheet-fed gravure and rotogravure.

Technically, this third group in its entirety is an "intaglio" process. The printing elements are all *below* the plate surface, having been cut, scratched, engraved or etched *into* the metal, to form ink-retaining grooves or cups. Surplus ink on the surface must be wiped or scraped off after each inking and before each printing impression. Wiping or scraping to remove surface ink to establish the necessary non-printing areas leaves a proper amount of ink in the grooves and cups of the low areas. Printing is done with considerable squeeze, which forces the paper *into* the plate. When it comes out it brings the printed ink impression along with it. In small edition, hand-press intaglio printing, the paper is often dampened to facilitate forcing it into the plate.

Printing from Assembled Plates

Letterpress was born and brought up to assemble all sorts of separate printing material belonging to the "relief group."

Chinese wood blocks cut hundreds of years ago can be grouped with modern photoengravings made yesterday. Plates from all over the world can be set up in forms and printed together, provided they qualify as relief printing plates.

Photoengraving is the largest source of supply for relief plates to be used for printing pictures or designs, and these can be made by thousands of different engraving shops, for anyone who wishes to have them made. But to be sure that they are properly made for the *kind* of letterpress printing to be done and the paper on which it is to be done, the buyer should be well versed in the intricacies of the processes of both engraving and printing.

Printing from One-piece Plates

Lithography, offset and gravure processes cannot use assembled plates and type forms as is done in letterpress. Text and pictures printed by these processes must first be reproduced photographically, making negatives or positives as required by the process used. These separate photographic units are set up in their proper position before any platemaking is started. Then the printing plates or printing cylinders are made as a single unit, in one piece, from the photographic setup. All of the manufacturing details connected with platemaking for these methods are taken care of by the lithographer or the gravure printer.

Chapter II

What Engravers Call Solids and Tones

How These are Reproduced With Printer's Ink

II

Solids and Tones

The copies to be reproduced by any or all of the processes which have been described are of two basic classes. These have what engravers call "solids" or "tones."

In this business, a solid is the maximum concentration of ink that will produce the darkest value of the particular ink being used. A solid of black ink will be as black as that ink; a solid gray will be the maximum value of that particular gray ink. This principle applies to all printing inks, regardless of their colors.

A *tone* printed with any one ink is always *lighter* than the solid produced with that same ink.

In drawings and paintings, great varieties of tones can be produced by manipulation of the pigments and paints; more can be applied in some parts and less in others. White and other lighter colors can be mixed with darker paints to produce tones.

But in the printing processes the ink offered to the printing form by the inking mechanism of the presses provides every area with exactly the same amount of ink; this amount is just enough to produce a solid; no more, no less.

To produce the effect of solids and tones with uniform ink distribution, something must be done with the ink to simulate "mixing" something with it in the "tone" areas, without impairing its power to produce solids in other areas. The best available material with which to do this is the paper on which the form is to be printed.

Successful "mixing" of paper and ink depends upon two things. First: on the formation of the printing pattern; and second: on the way the eye sees this pattern when it is printed.

All printing forms in letterpress or lithography are patterns consisting of some arrangement of lines, dots, squares or other shapes. These may be large or small, straight or crooked, regular or irregular, close together or far apart, separate or joined, and their variations in arrangement are seemingly unlimited. The open spaces between or around them will give each a background consisting of the paper on which they have been printed.

When these printing elements are sufficiently large, and far enough apart, the individual shape and size of each will be a distinctly visible solid, provided they are well printed. If the elements are too small to be seen as separate solids they will apparently blend into their background of paper. The effect will be a "tone" lighter than a solid of the ink and darker than the paper.

We see this apparent difference between solids and tones because of the limited "resolving power" of the eye.

Small, concentrated type matter, as in a newspaper, is distinct at reading distance; each character is individually clear. But across the room the lighter paper and the dark ink of the printed characters blend together, and we see a tone rather than separate, distinct elements. A distant brick wall, a far-off mountain range, or even the checkered pattern of a suit of clothes, all appear to be tones when the distance so reduces the size of each element as to make it beyond the limited resolving power of the eyes. This same effect of blending and merging of separate dark and light areas can also be attained by making the dark ones so small that they seem to mix with their background, even at reading distance.

In utilizing these two processes of reproduction and printing, original copies like line drawings, lettering and other subjects in which the separate elements are clear, distinct and well separated, present no difficulties. Each element being a distinct solid, it need only be reproduced and printed as such. The aggregate of these will constitute a reproduction of the original.

But there are other kinds of copies which have light and shade, blended variations which seem continuous and which do not have the distinct well-separated solids of line drawings. Photographs, wash drawings and paintings are typical. They are called "tone copies," and to reproduce them with printing ink on paper their tones must be subdivided into minute, separate units, with spaces between or around them. Each of these units must be sufficiently large to print as a solid, but at the same time each must be small enough to create the visual effect of blending with its background of paper.

The Halftone Screen

In the letterpress and lithographic reproduction processes this breakup is obtained by first photographing the "tone" copy through a "screen." Thanks to several mechanical, optical and photographic features of the processes, copy tones become translated into a printing pattern of individual dots. The sizes of these dots, in turn, control the amount of ink which each will deposit when they are printed. A remarkable feature of the process is that these printing dots *will* vary in size and shape, according to the lights, shades and details of the copy. In this manner, the copy tones become reproduced by the visual effect of thousands of tiny printed dots, perhaps

of many different sizes, apparently blending with their paper background.

Any copy which requires this "screening" in reproduction is known as a "tone" copy, and calls for the "half-tone process" of reproduction.

But many copies, such as fine pen and ink, dry brush, stipples, charcoal or crayon on rough paper, spatter work, or any other art technique which gives the *visual* effect of tones, *may not* need screen photography to reproduce them.

The dividing line between the need for screen, or no screen, depends almost entirely upon the size and spacing of the separate elements of which the copy is composed.

If the copy consists of distinct black lines, dots, or other shapes on clean white paper, each of which can be sharply photographed; and if in the printing plate itself, the open separating spaces between or around each are large and distinct enough to permit of their being properly etched or otherwise treated so they will not print, then no screen need be used in reproduction.

These are called "line" copies. All others will be "tone" copies.

But there is one extremely important thing to watch out for, especially in letterpress: lines and dots which may be distinct enough and sufficiently far apart on line copies that are to be reproduced in their actual size, or larger, may become entirely too small and close together when *reduced* in size. When this happens, there is little choice but to fall back on the reproduction screen method, even though it may impair the appearance of the finished prints.

The technical difference between tone and line copies, and the need for screening one and not the other, obtains

only in the letterpress and photolithographic processes. In rotary and sheet-fed gravure, a screen of some sort is invariably used on all copies, even type; these processes of the intaglio group do not reproduce type or line work the way the other two handle it.

Copies which consist of both tones and line work, and which are to be reproduced either by letterpress or lithography, are called "combination" copies, and require a combination of the screen and line methods.

In letterpress, the kind of paper on which the plates are to be printed may have a definite bearing on the need for more open line spacing or the use of a coarser screen. Plates for printing on rougher papers require more open spaces and deeper etching than when the printing paper to be used is smooth.

Before the discovery of photography, each of these three processes was creative; the artisans who worked them could not be absolutely certain of what they would end up with until the first proofs had been pulled. Photography changed this: it made them reproductive and materially reduced the creative possibilities resulting from handwork. The manual arts are still required in all of this work, but usually as a supplement to photography. Creative work, if required, should be done on the original copies, before they take their place before the reproduction cameras.

Chapter III

Reproducing Solids

for Letterpress by the Line Process

III

Reproducing Solids

Making a Line Negative

The first step in this process is to photograph the copy to the required reproduction size. The cameras used for this are much like any others in principle, except that they are quite large, rigidly constructed, and mounted on stands suspended from springs to absorb vibration. The camera slides on this stand, but can be locked in any desired position. At one end of the stand, in front of the lens, is a copy board or frame, illuminated on each side by powerful lights.

Line copies are photographed on plates or films which have an extremely contrasty, sensitized emulsion. After exposure and development the result is a "line negative."

For the best possible results, line copy should be clean in the whites and absolutely sharp and black in the lines, dots or other solids. Colors, smudges, dirt or other imperfections in the whites of the copy will result in imperfect opaque blacks in the line negative. These black areas in the negative are important. They must be so black and opaque that they will have no semblance of "tones" anywhere. Likewise, the black elements of the copies should be sharp, black as it is possible to make them and with absolutely no grayness, shading or weakness anywhere.

Line copies which meet these exacting requirements will produce the best line negatives. In the negative, the

whites of the copies will be opaque black, with no imperfections. The blacks of the copies will be clear and completely transparent. If the transparency of the blacks is foggy, dirty or has other imperfections in the line negative (and it will have if the copy is not right), then these faults will also appear in the etched plate, to the detriment of its quality.

In making any photographic negative, the copy values are always reversed. In the negative, the whites of the copy become black. They reflect light, through the lens, to the sensitized photographic emulsion. On development, this exposure to light results in areas of opaque black. If the blacks of the copy are definitely black, they reflect little or no light, and the corresponding areas of the sensitized photographic emulsion are not affected. Development does not affect them either, and they become sharply clear and transparent areas in a background of opaque black.

A "positive" is any print made photographically from a negative. This process reverses the values of the negative. All blacks in the negative become whites in the positive, all whites in the negative (the transparent parts) become black in the positive or print, and the original values of the copy become reproduced.

In making the negative, the image is also reversed, from left to right, and it "reads" backwards. In a print, reversal is repeated and the image not only reads right again, but is "as copy" in its black and white values.

Negative Turning

In the photoengraving process the print from a negative is made on a sheet of metal. When this is etched and becomes a finished plate, the printer will turn it

over to print it on paper, so the image must read wrong on the plate. To accomplish this the negative must be turned to read right before the metal print is made. This can be done by photographing the copy through a prism on the camera lens, or by stripping the negative from its original support and turning it over onto a new one.

In the stripping and turning operation, negatives can be set up in groups for the purpose of printing and etching several subjects at one time. Also, negatives can be cut and combined in almost any desired arrangement. A sheet of plate glass with negatives assembled on it is called a "negative flat." After completion, these flats pass on to the printing room to be printed on metal.

Making and Developing the Print on Metal

Line work is usually printed on zinc of 16 gauge, or 1/16″ thickness.

After the metal sheet has been cut to proper size, it is thoroughly cleaned and scrubbed with water and powdered pumice. A solution of water, egg albumin and a chemical called Ammonium Bichromate is flowed onto the cleaned metal, evenly distributed and dried with mild heat in a "whirler." When thoroughly dry it is placed in a printing frame with the sensitized side in contact with the negative, and the print is made through the negative to the metal with very powerful arc lamps.

The light from the printing lamps passes readily through the transparent areas of the negative and acts on the sensitized surface of the metal in a manner which makes it insoluble in water. The opaque areas of the negative do not allow any light to reach the sensitized coating, so these do not become hardened and will wash away during development of the print in water.

When the print has been suitably exposed in the printing frame, it is removed and "rolled up" evenly with a thin black "etching ink." This rolled-on ink film completely covers every area of the print, hardened and unhardened. Development consists of gentle washing in running water. Slowly, the water dissolves and removes the unhardened parts of the coating, and as it goes away, the ink which is on top of it goes along also. But the hardened parts of the print are not soluble in water, so they stick. The ink on them, being somewhat greasy, also sticks. The result is an "ink print." Except for a possible difference in size, this print should look exactly like the original copy, although it will be facing the other way if the negative has been turned over.

With this picture of the ink print before us, it will now be easy to understand the need for opacity in the blacks and transparency in the other parts of a line negative. The black film of the negative must shield the sensitized coating so completely that it will be entirely unaffected by the printing light, and when it washes away, it must be completely removed, exposing clean, bare metal. These are the plate areas that will be etched, and if they are not clean they will not etch properly.

The ink used on these prints is not only somewhat greasy, but is also slightly sticky. After development of the print it is next dusted with a fine resin "topping powder" which sticks to the ink of the print, but not to the metal, from which it can be dusted with a wide, soft brush. The powdered print is then heated sufficiently to melt the "topping powder" and after cooling, every line or dot which has been printed on the metal will be covered with an acidproof protection. The ink alone is not sufficiently acidproof and, if not topped up the acid would go through it and spoil the plate.

Etching the Plate

When these operations have been completed the back of the plate is covered with some acidproof material such as shellac, and the larger, open spaces are roughly painted in with liquid asphaltum, which is also an acid-resisting material. The need for painting in these large open spaces is to reduce the heat generated by etching, to confine the etching action of the acid to the essential areas to be etched, and to provide "dead" metal or "bearers" which may be required at later stages in the life of the plate, as explained in the chapter on electrotyping.

Line etching usually requires several "bites" of the acid to assure proper depth in the larger spaces. But in doing this, provision must be made to prevent the acid from eating under the protective covering of the printing areas. If it did, it might "chew" some of the finer lines completely away. Protection against lateral etching is accomplished by brushing on another resinous powder called "dragon's blood." It takes skill and experience to brush this powder tightly against the sides of all areas which stand in relief as a result of the etching bite, and at the same time to brush it cleanly out of the *bottom* of the etched parts. When heated, this powder melts and provides the protection necessary to keep the acid from etching sideways and undercutting the lines.

To assure protection on all sides, powdering is done "four ways": from North, East, South and West, but in only one direction at a time. It is burned in after each directional brushing, which prevents any being removed when the direction of the powdering is changed.

After a line plate has been given its first bite, and begins to have relief, four-way powdering must be done for each successive bite. Most line work requires at least

four bites, but the action of the acid does not necessarily affect all areas equally. When the finer spaces have been etched as deeply as they require, the powder is allowed to fill them up so they will not etch further while other areas are being given their additional bites.

Any attempt to force excessive depth into the finer spaces may result in undercutting and "chewing" the plate. The width of the spaces in fine, close line work invariably limits their maximum etched depth. This is a bit of manufacturing detail that is worth keeping in mind.

Letterpress printing may be done on many grades of paper and the surfaces of these papers may vary considerably. Paper which has a surface that is rough and "hilly" requires deeper and more open plates than do the smoother finishes. Copies for line reproduction should therefore be made, or selected, with a thought to the kind of paper on which they are to be printed.

After completion of the etching, the ink top and various deposits of melted powder are cleaned out of the plate and it is ready to be routed. Routing is done with a high-speed cutter much like a hand-guided milling machine. It gives the plate additional depth in the larger areas and it can also be used to rout down or "jump out" the dead metal or bearers which were painted in prior to etching. Routing is seldom required in small areas where the depth of etching alone is sufficient.

Zinc line plates can also be made with a sensitized acidproof protective covering called the "cold-top." This is sensitized shellac and development is done in alcohol, as shellac is not soluble in water. Cold-top plates require no burning in nor topping powder, but they do require the four-way powdering during successive etching bites. As cold-top prints require little heat there is no tendency

to distort the metal. Consequently they are often used in color work where accuracy of register is important.

Line plates can also be made on copper, in which case the "top" is sensitized glue. This top requires burning in at a fairly high temperature, but it is very useful if the work is extremely delicate in texture and if it may require re-etching locally. It is also known as an "enamel" top; it is the most durable of any, and stands up better during the etching or re-etching operations.

Chapter IV

Reproducing Tones

for Letterpress by the Halftone Process

IV

Reproducing Tones

The Halftone

Basically, the operations for making halftones are almost identical with those employed in the line process, with one exception. The reproduction negative is made through a "halftone screen."

The regular halftone screen consists of two pieces of optically flat plate glass, ruled with black parallel lines. The spacing between the lines is a little greater than the width of the lines themselves. The number of lines to the linear inch (not the square inch) is used to designate the "screen fineness." The usual screens are: 50, 55, 65, 85, 100, 110, 120, 133 and 150 lines to the inch, although there are screens of 175, 200, 250, 300 and 400 lines, but these are not generally used. These ruled glass plates are cemented together with the lines crossing at right angles, leaving little square openings separating the crossing lines. The number of these screen apertures in each square inch is determined by squaring the number of lines in every linear inch. Thus a 50-line screen will have 2500 apertures, a screen of 120 lines will have 14,400, and the 150-line screen will have 22,500 openings in each square inch. These apertures in the various screens are essential to the formation of the printing dots of the halftone plate.

The choice of the proper screen fineness depends upon the kind of paper on which the plate is to be printed. In

line work, this same principle of fineness also applies, but the "fineness" is controlled by the copy itself and the engraver cannot do anything about it if it is wrong. In the halftone process, however, the engraver can do a lot about it, for he can designate, and use, the screen of suitable mesh best adapted to the paper and printing conditions under which the plate will be printed. Screens recommended for use with different kinds of paper are listed later in this article.

The Halftone Negative

The selected halftone screen is placed in the camera, in front of the photographic plate, or film, but not in contact with it. The space separating the screen and plate is important, and must be varied with screens of different line fineness, as well as with different amounts of reduction or enlargement; it is known as "screen distance."

In its proper position in the camera, with correct "screen distance," the shadows cast on the photographic plate by the crossing screen lines are not absolutely sharp; they are intentionally "out of focus" by precisely the right amount. As a consequence of the soft edges of the screen line shadows, the tiny beams of light which pass through the screen apertures also have soft edges. Their centers are their brightest parts, and this intensity diminishes as their edges become merged with the screen shadows. When these little light beams reach the photographic plate they become tiny discs of light, brightest in their centers and less bright on their edges.

Now comes the remarkable feature which makes the halftone process possible.

The light which passes through these screen apertures during the making of a halftone negative does not come

directly from the lamps which are used to illuminate the copy. It is reflected by the copy, and the only light reaching the screen, after having passed through the photographic lens, is that which the copy itself has reflected. If the copy has variations of tone, the light reflected by it will vary in intensity, and these variations will be proportionate to the lightness or darkness of the copy tones.

The disc of light which will act on the photographic emulsion may, therefore, have many different degrees of brightness and each will be more intense towards its center, than on its edges. These light beams affect the sensitive emulsion in such a manner that when the exposure is chemically developed, the area affected by each beam will turn black. The developed negative will consist of thousands of tiny black discs, and the sizes of these will vary in exact ratio with the intensity of the light from the copy which caused them to be formed. Bright sky will have produced larger black discs than those formed in the less intense middle tones. The discs in the shadow areas will be still smaller.

These size variations result from the fact that every beam is more intense toward its center. A bright beam will form a larger disc than a weaker one. The effect is not unlike pressing a soft rubber ball on a hard surface. The harder the pressure, the greater the area of the ball that will be in contact with the surface.

Under casual inspection a halftone negative looks very much like any other photographic negative, the bright parts of the copy are dark and the dark copy areas are much lighter. But by examination with a magnifying glass, we get a very interesting demonstration of the wonders of the process.

The brightest copy areas, such as its strong whites, will have made the black discs so large that they will overlap.

The transparent areas in the center of each group of four discs will be very small. Lay four quarters on a sheet of white paper and let them overlap at points N. E. S. and W. Each will represent one black disc. The open space in the center will represent the small transparent spot in the halftone negative.

The Halftone Print on Metal

When printed on metal, these tiny, separate open spaces will become little black dots on the plate; the larger black discs will form the open spaces between and around these black dots. These larger open spaces will be the ones that will be etched. When inked and printed the black dots will be little islands of ink on a sea of white paper. The effect upon the eye will be that of a very light tone.

If the four quarters are still laid out in their overlapped position, lay four pennies on each of them, center to center. These pennies will represent the black disc formation of the darker or middle tone areas of the negative. When printed on the sheet of metal the "pennies" will be the areas to be etched. They will produce smaller areas of white and greater areas of black, and the tones will be darker.

The same thing takes place in the shadows. In fact, it takes place over the entire area of the subject, and with a great many variations in dot sizes. The degree of variation will be whatever the tones of the copy call for and, if the operations are properly carried out, the tones of the copy will be reproduced with remarkable fidelity. The individual dots are all so small and close together that the eye does not detect each one as a single unit, but will

blend them with their white paper background, which it sees at the same time. The results then will be:

Less black ink, more white paper—lighter tones.

More black ink, less white paper—darker tones.

The white paper between printing dots results from etching the open spaces between dots, just as the corresponding spaces between lines are etched in line work.

Halftones and Line Plates Compared

The physical similarity between line plates and halftones lies in the fact that each has printing lines, dots or other shapes. And each has non-printing areas between, which have been etched. So line plates and halftones can be inked and printed at one time on the same press and with the same inking mechanism used for both.

The *technical* difference between a line plate and a halftone is this:

A line plate is made by photographing a copy *without* using a screen in the camera.

A halftone plate is made by photographing a copy *with* a screen in the camera.

So far as the technical terms are concerned, the copy itself has nothing to do with it.

A copy consisting of the simplest bold arrangement of lines may, for some good reason, have to be photographed through a screen. If so, then the plate will be a halftone.

A tone copy such as a photograph may, in exceptional cases, be photographed without a screen. Regardless of how it may appear when finished, the job will be a line plate.

There are several methods used in the preparation of copy which result in screen effects right on the copy itself. When such copies are properly prepared, they can be re-

produced by the line process. The reproduction may look like a halftone, but it will be a line plate, technically, if no screen is used in photographing it. These are called "screened" or "shaded" copies.

Shading films which are simply laid on copies and which are not in absolute contact with the copy surface sometimes cause trouble. If the lines or dots of these films are out of contact they may cast shadows on the copy and cause heavy black smudges in the plate. Shaded effects which are applied with an overall adhesive, or which are chemically developed on the copy, do not cause this trouble.

So, the difference between a line plate and a halftone is determined by the manner in which it has been made, rather than what it looks like after it has been made. But there may be quite a difference in the billing of the job.

The type of halftone screen most generally used is the "cross line" screen, in which the lines are uniformly straight and crossing at right angles, or 90 degrees. These are "symmetrical" screens and all dots produced by any one screen will be the same distance apart *at their centers* regardless of their sizes.

A halftone negative made through one of these screens, from a copy which has a screen pattern on it, such a "shaded" copy, or a halftone proof, will usually cause an objectionable "pattern" to form. This may consist of a checkerboard effect, or an irregular "moire" like watered silk. It is often possible to reduce or even eliminate this pattern by turning the angle of the screen in the camera, or by turning the copy at a different angle to accomplish the same result. Reproductions of steel engravings or fabrics such as ribbed hat bands often show patterns or moires when the halftone screen causes a conflicting effect of crossing dots and lines.

There are also screens which have the lines crossing at 60 degrees instead of 90; "one-way" screens which have all the lines running in one direction instead of crossing; wavy line screens; screens with unequal instead of equal line spacing; and those called "mezzograph" which have a granular structure instead of lines. Finely woven wire cloth, or even silk bolting cloth,* can be used as a screen, under certain conditions.

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* *Silk bolting cloth is used in the "silk screen" process, but it is not for the purpose of creating halftone dots as in the halftone process. Silk screen work is a stencil process of painting. The screen itself merely supports the stencil and its open spaces permit the paint to be squeezed through them by the use of the "squeegee." The process is a valuable member of the graphic arts, but it is not "printing" as typified by plates, ink, paper, type and printing presses. It is used extensively on various synthetic and other materials.*

Chapter V

Letterpress Engraving, in Detail

Halftones, Highlight Halftones and Combinations

"These . . . processes . . . are extremely flexible and versatile. This makes them extremely sensitive to the touch of the guiding hand. For better or for worse, they need to be pretty thoroughly understood before any attempt is made to use them."

from Chapter I of this story

V

Letterpress Engraving, in Detail

The two styles of plates, line and halftone, lay the foundation for all of the different kinds of plates made by the photoengraving process, but there are many variations and combinations of these two.

The order in which they are listed and described, as well as the numerals opposite each, coincide with the side notes of the Photoengravers Scale.

1. Square finish halftones on copper.
1-11-33-34. Square finish halftones on zinc.
2. Combinations on copper. (Halftone and line work combined on one plate.)
2-35. Combinations on zinc. (Halftone and line work combined on one plate.)
3. Highlight halftones on copper.
36. Highlight halftones on zinc.
4. Combination highlights on copper.
37. Combination highlights on zinc.
5-6-38. Fine screen, coarse and extra coarse (blow up) halftones on copper and zinc.
7. Line plates on copper.
13-14-19. Line plates on zinc.
43. Line plates on zinc with Ben Day.
44. Laying Ben Day tints.
15. Solid tint plates on zinc.
16. Reverse plates on zinc.
17-45. Color plates.
20-47. Extra negatives.

21-22-48-49. Combining negatives by stripping, double printing and surprinting.
23-24-50-51. Outlining, vignetting, ovals, circles and round-cornered halftones.
25-52. Re-etching.
Two-, three- and four-color process plates.

The Halftone (*Side notes 1, 11, 33 and 34*)

Copies for halftone reproduction should be clean, smooth, flat and without color.

Cleanliness in halftone copy is more important than in line copy, because smudges and stains are like "tones" and the screen process may reproduce them, to the detriment of the finished result. Pasters should also be avoided, as they may cast shadows which will also be reproduced, and these are difficult to remove.

Colors often reproduce, photographically, either lighter or darker than they appear to the eye. There are ways to overcome this difficulty, but they involve the use of certain processes of color photography which may add considerably to the cost of the plates.

The indication of sizes to be followed in reproduction should be on the margin, or the mount, of the copy—not on its face. Marks on the *face* of a copy may show in the reproduction.

Instructions written on the back of unmounted photographs should be done with a very soft pencil, or they may show through on the front. Tight paper clips which mark the edges of photographs are also trouble makers.

Having good copy and clear instructions, the first step in halftone reproduction is to determine the fineness of the screen to be used. This is almost invariably based on the kind of paper to be used in printing the plate.

Every well-equipped engraving shop has a large assortment of screens from which to choose. They range from "coarse" to "fine," the usual number of screen lines to the linear inch being: 50, 55, 65, 85, 100, 110, 120, 133, 150.

The ideal printing quality of a halftone requires that each dot formed by any of these screens will print cleanly.

Rough paper has a surface of hills and valleys, somewhat like a miniature piecrust. If a fine screen plate is printed on rough paper, a good many of the dots will print on the top of the hills in the paper, and a good many others will stand over the holes or valleys and they will not print at all. The result will be a broken, highly unsatisfactory printed impression. Extra printing squeeze sometimes helps, but it is not the whole answer. The dots on the hilltops get pushed so far into the paper that they become buried and gain considerably in value; the others perhaps just touch the bottom of the valleys, if they reach that far, and the printed result will be ragged and "mealy."

The way to approach this problem is to use a coarser screen, with fewer dots to the square inch; a screen which more nearly "fits" the irregularities of the paper surface.

Experience has shown that:

Newsprint requires screens no finer than the 65 line.

Bond paper, from 85 to 100.

Machine finish and English finish, 100 to 110.

Super and machine coated, 110 to 120.

Best coated paper, 120, 133 and up.

The use of these screen varieties calls for the acceptance of certain compromises.

Tones, which may range from very light to very dark can be reproduced in any screen fineness.

Detail cannot.

The amount of detail in the finished print will depend upon the number of dots per square inch. This will be

established by the screen fineness selected for the paper to be used.

Obviously 10,000 dots to every square inch (100 screen) will reproduce more detail than will 2500 dots (50 screen) in a reproduction of similar size.

The camera equipment for halftone photography is practically the same as for line work, except that it has a screen holder that will take screens of different sizes, and which is capable of various adjustments to provide the proper screen distance.

In screen photography, the methods of making the exposures, the timing, and the lens diaphragms used are totally different from those employed in line work. Different operators have their own special methods, but in general, four exposures are required to make a halftone negative of a tone copy. These vary in duration, in the sizes and shapes of the diaphragms used, and in the methods of development. The purpose of these variations is to get the greatest possible range of dot sizes, which in turn will give to the printed image its greatest possible scope of tonal qualities. These multiple exposures are made on the same photographic plate, covering the lens when making the changes of diaphragms.

Screen negatives have one peculiarity which screenless photography does not have. Namely: that the screen dots cover the entire area of the image, in its pure whites as well as in its darker tones, and even out on its margins and on the copy board to which the subject has been attached. Excess screen is removed in later operations called "finishing." Under certain conditions, screen dots can be blocked out of the pure whites by "highlight" photography, but this method is the exception rather than the rule. When it is used, it will eliminate the highlight dots from *all* the whites of the copy. Very often this

is undesirable; removal may be required from some whites but not from others, in which case a modified method must be used.

After a halftone negative has been finished, it is coated, turned, and printed on the metal in practically the same manner as for line work. Then the metal can be etched.

In a halftone print on metal, which has screen overall, the areas which will be attacked by the acid will be the open spaces between the little dots. Each printing dot, being protected by its top of acidproof covering, will be unaffected. Halftones of 120 screen or finer usually require but one bite to obtain sufficient depth in the small areas between the dots. Plates of coarser screens require one or more powder bites, as used in the line etching method.

One or more "overall" acid bites given to halftones produce what are called "flat plates." While they could be inked and printed at this stage, the excess screen around the outer edges should first be cut away by a machine method called "beveling." This operation removes the outer margins of screen, produces what are called "square" halftones (they are "squared" rather than "square"), and at the same time leaves a narrow flange of metal all around, which can be used in nailing the plate to a block to make it "type high," which is .918″.

The quality of accuracy in reproduction from flat etched halftones depends upon a number of factors: the skill of the operators, the nature of the copy itself, and the kind of paper to be used in printing. It is entirely possible that the results may be entirely acceptable without further work. But if the detail or tonal qualities of the copy are paramount items, if the paper is not perfectly smooth, if the presswork is to be done at high

speed, then some local work will almost invariably be required to meet the printing conditions.

Tones that are too dark can be lightened by local application of the etching acid, which is intentionally permitted to attack the *sides* of certain dots to reduce the area of their printing surface. As this makes the dots smaller, the tones which they print will be lighter. But it may be difficult, or even impossible, to re-etch certain small groups of dots without attacking others nearby. This can be avoided by "painting in" those areas which are *not* to be re-etched, using an acidproof protective material such as asphaltum and turpentine. Then the unprotected areas can be re-etched without fear of harming those which have been protected.

Painting in is also called "staging" and it can well be a long time operation if there is much intricate detail to be covered.

When some of the halftone areas are too light, they can be darkened somewhat by "burnishing." The areas to be increased in tone are rubbed with a hard, smooth steel tool which spreads the dot surface, and in making it larger will also make it print darker. Burnishing not only spreads the dot surface but also tends to make it slightly lower, therefore the operation cannot be carried to any extreme, lest the plate lose its required depth in the non-printing grooves and valleys.

Re-etching can be done even after the plate has been finished and proofed, provided the protective top remains on. Burnishing sometimes takes the top off and if any re-etching is then required, a new top may have to be put on the plate.

Square finish halftones can be made on either copper or zinc, but if zinc is used re-etching is seldom attempted, as the zinc top does not hold well during re-etching.

Combinations *(Side notes 2 and 35)*

A combination plate consists of both halftone and line work, etched together on the same plate. Usually the line copy is separate from the halftone copy.

The halftone and line negatives are each made in the usual manner, but when they are stripped and turned they are combined on the negative flat. In principle this is comparable to cutting and combining the copies themselves, but is a much more delicate operation because of the extreme thinness of the films. This may give rise to the thought that if the copies *are* combined, it would save the cost of stripping the negatives together. Let's see what would happen if that were done—if one-piece combination line and halftone copy were used.

In making the screen negative of combined line and tone copies, all of the line work would have screen over both its blacks and whites. So a separate line negative would have to be made, even if the copies were combined. The next bit of trouble would be caused by parts of the tone copy appearing in the line negative. It might be difficult, if not impossible, to cut these away cleanly and get a perfect joint when the actual tone negative was inserted in position.

Usually the best way is to work with separate copies and assemble them in the stripping operation, following an accurate layout or guide for the respective positions of the negatives.

After a combination negative flat has been made up, it is printed on the sensitized metal in the usual way. Then it is etched for the halftone bite. When the screen areas have attained their proper depth, they must then be painted in so they will not etch any further when the line work is given its deep etching powder bites.

In combination plates, the finishing, re-etching, burnishing, tooling and routing follow the same procedure as for separate halftones and line plates.

Combinations can be made in any screen and on either copper or zinc.

Highlight Halftones *(Side notes 3 and 36)*

Under ordinary conditions, when a halftone negative is made, screen appears overall. It appears in the whites, middle tones and blacks. In the reproduction of copies such as pencil drawings, screen would appear in the open spaces between the pencil lines. In facsimile reproduction this is undesirable, but there are several methods available to drop out the screen in these whites.

One process is the "highlight" negative. Photographically, this is complicated and requires particularly adaptable copies, with well defined whites and no extremely delicate light pencil lines. By manipulating the diaphragms and with special development of the negative, the dot formation in the whites becomes sufficiently well closed up so that it does not print on the metal.

Masking is another way to make these plates, but this requires a specially made overlay of solid blacks covering all areas of the copy which are to be held. A line negative of this overlay or mask, stripped on the halftone negative, will block out all whites in the print. Double exposures with and without the mask in position are also used, and there are many other methods employing special materials that enable the operator to "hold" certain areas of the copy and "drop out" others. Finally, the metal print can be made from a conventional screen negative and the plate can be "highlighted" by painting in all the lines to be held and then etching away all of the undesired

screen areas. The choice of one method over another depends very largely upon the nature of the copy and the results desired. The painting in and dropping out method is often used when only certain areas are to be highlighted. Highlight plates for publications which use no make-ready in printing often have screen left in flesh tones and other areas, where the possibility of hard printing edges would be detrimental.

Highlight negatives are printed on metal and etched like combinations, to give them the desired depth in the more open spaces.

These plates can be made in any screen and on either copper or zinc, but copper is preferred because it gives better results if any re-etching is required.

Unless the subject is very bold in technique, coarse screens should be avoided, as they might cause delicate lines to be too badly broken, losing detail and sharpness.

Combination Highlight Halftones *(Side notes 4 and 37)*

These, as the name implies, are combinations of highlight and line negatives stripped together, and are etched and routed like combination plates.

Chapter VI

Letterpress Engraving, continued

Fine, Coarse and "Blow-up" Screen Plates.
Line, Ben Day and Reverse Plates.
"Key" Plates and Ben Day or
Solid Color Plates.

VI

Letterpress Engraving, continued

Fine, Coarse and Extra Coarse Screen (Blow-up) Halftones (Side notes 5, 6 and 38)

Both coarse and fine screen halftones require special handling. In addition to the powder bites and deep etching required with the coarse screens, both these and the plates of very fine screens have to be etched on flats of their own; they cannot be properly handled on flats which carry plates of the intermediate screens.

Screens of 50 lines to the inch are about as coarse as can be made in direct halftone photography, because of the optical principles involved. But in many instances plates which are much coarser than the 50 lines may have to be made.

It is done by making either a halftone negative or an etched screen plate with a finer mesh and then enlarging it, photographically, or "blowing it up."

For example: a plate of 25 screen, 8″ wide, is wanted. If the preliminary negative is made with a 50 line screen, it should be 4″ wide; 25 being one-half of 50 and 4 being one-half of 8. A sharp, black and white photographic enlargement 8″ wide made from this negative will be a 25 screen print. From this a same size line plate can be made, on either copper or zinc. If the first negative is of 100 line screen, it should be but 2″ wide. By enlarging this to 8″ the same 25 screen result will follow.

Before the final line negative is made, the enlarged

photographic screen print can be retouched with black ink. Solids can be added, dots joined to get better line effects, and whites can be painted out to simulate the highlight process.

When an etched plate is used as the preliminary step, it can be first re-etched, burnished, tooled, or otherwise treated. Then a perfect, sharp proof must be made from it, and from this proof the line negative can be made for the final plate.

Line Plates on Copper *(Side note 7)*

For certain kinds of line copy, it is desirable to etch the plate on copper. Furthermore, many publications which print from lead mould electrotypes require copper etchings. They withstand the moulding pressure better than zinc, and copper is better for soldering, which frequently must be done. Zinc melts at a low temperature, almost as low as the solder. Copper can withstand more than enough heat to do any kind of soldering.

Copper line plates are made with the enamel "glue top" and can be re-etched if necessary.

The manufacturing procedure for making copper line plates is the same as for zinc, except for the metal used and the sensitizing solution flowed on it.

Line Plates on Zinc *(Side notes 13, 14 and 19)*

The photomechanical processes for producing zinc line plates have been explained in previous sections of this article. These descriptions cover the reproduction of what may be considered "normal" line copy. But all line copies are not "normal"; some are very much out of the ordinary.

Copies with weak lines may have to be specially handled in negative making; touching-up on the print may be needed before it is etched; the subject may be too difficult to be grouped with others and will require the luxury of a flat of its own.

"Difficult" copy and "shaded" copy does not mean that they are to be avoided. They simply require special care and individual handling; quantity production methods are not good enough for them.

Line Plates on Zinc, with Ben Day *(Side note 43)*

In the previous paragraph reference is made to "shaded" copy. This means copy which has the equivalent of a screen of some sort as a component part of its technique. It must be reproduced by duplicating every line or dot of its shaded pattern.

But there are also certain kinds of line plates, made from copies that are *not* shaded, but which have a screen added to the plates before they are etched.

This is accomplished by the Ben Day process. It is described in the following paragraphs. After the Ben Day screens have been added, the etching and all subsequent operations are the same as if a "shaded" copy were being reproduced.

Laying Ben Day Tints *(Side note 44)*

This process gets its name from Benjamin Day, its inventor.

It is a method for printing from "shading films," either on the metal plate before it is etched, or on the negative, before it is printed on the metal. The purpose is to apply screen patterns of one form or another to certain areas

of the subject, in which no other screen or line formations appear in the copy.

The shading films are supplied by the manufacturer in various sizes and in more than a hundred different patterns. The films are semitransparent, mounted on light wooden frames, and the surface of each is a relief printing pattern of the screen, line or dot design of that particular film. The application of these patterns, to either the negative or the metal, is accomplished by inking the relief surface of the film just as an etched plate would be inked. The inked film is then placed in contact with the surface to be treated, and the print from it is made by rubbing the back of the film to make the transfer of the inked pattern.

Ben Day ink is somewhat tacky and greasy; it will take the topping powder like a regular "ink print." When the powder is burned in, it protects every dot or line of the pattern, and then the plate can be etched.

There are many variations possible, which give this method considerable scope. One in particular is that which permits the Ben Day operator to apply the shading pattern in some areas but not in others. It is done by "gumming out" or "gamboging" all areas in which *no* tint is to be laid. The material used for this is a yellow, water-soluble substance called "gamboge." It can be painted on either the negative or on the metal. It has about the substance of rather thick water-color paint, and by applying it with a fine brush it can be made to conform to extremely delicate outlines. After this, the selected Ben Day film can be printed over the entire area of the subject, on the open spaces and overlapping onto the gamboged areas as well.

The ink used for printing these films has considerable grease in it and it is not soluble in water; but the gam-

boge *is* water-soluble. When the print is washed in warm water the gamboge dissolves, and as it washes away, any ink laid on it by the film is carried off with it. The printed pattern, however, will stick because its grease content prevents its removal by the water. The gamboge prevents this printed pattern from reaching any area of the metal, except in those to which it is to be applied.

Another phase of the operations is that the film can be reprinted any required number of times in the same area, but with a slight shift of position each time. This causes the individual dots or lines of the pattern to become increased in size, and the tone will become darker with each shift.

When Ben Day tints are laid on the metal plate, an ink print usually serves as a guide for the necessary gumming out. But unless the copy provides clean white open spaces in which the tint can be laid on the print, a change in method will be required.

One way is to "stain" the metal with a weak acid solution after the ink print has been made, and then remove the print to allow the tint to be laid. This stain serves as a sufficiently distinct guide for gamboging. Another way is to lay the tint on the negative instead of on the print.

When tints are to be applied to negatives, the areas of the copy to be tinted must be *black*. This will result in clear transparent negative areas, and the tints can then be laid on them.

Tints laid on negatives become reversed in values when the metal print is made. Black dots in the film pattern will become white dots on a black background in the plate.

To assure accuracy in outline and position of Ben Day tints, every area to be tinted should be well defined

in the copy by guiding lines. If the copy happens to be a rule border, these lines will serve as guides. Clouds, shadows, folds in garments and other shapes which have no outlines of their own in the copy, must be provided with them.

Guidelines which are intended to serve as such while the tints are laid can be removed before the plate is etched. If they are drawn in red they can be more easily identified, but they should be a good strong vermilion, not pink. Their removal from the plate will be assured if the copy is marked: "Take off red guidelines."

Guidelines should never be drawn in blue. This color photographs as though it were white and consequently the lines will not appear on the metal print. Open areas of the copy such as clouds, shadows, and other areas into which tints are to be printed *can* be painted over with light blue, to show where the tints are to go. This blue will not show in the print, but it will guide the Ben Day operator. As is always required, these areas should have guidelines surrounding them.

To obtain the best results with the Ben Day process, it is advisable to consult with the photoengraver before starting any complicated piece of work. It may save both time and money, and produce a better job too.

Screen negatives can also be used for laying tints by "surprinting." The print must be gamboged, then re-sensitized before the surprinting is done. (See Chap. VII).

Solid Tint Plates (Side note 15)

Square or rectangular tint plates, to print solids, can be cut to shape on the beveling machine, without making negatives or etching the metal. (See notes 17 and 45 for solid plates of irregular shapes.)

Reverse Plates on Zinc (Side note 16)

The photographic negative used for making line plates is reversed from the copy in values; whites of the copy become black in the negative, and blacks become white (transparent in the negative).

Frequently line plates are made which have this same reversal of values and which are "negative" to the copy.

Such plates can be made by first making a "positive" from the line negative. This is a photographic operation much like making a print, but it is made on glass or film, so that a metal print can be made from it. The etched plate made from this positive will be the reverse of the copy in values.

The use of the word "reverse" to indicate these changes is sometimes confused with reversal from right to left, to make the subject face the other way. To be on the safe side, it is just as well to specify what is wanted: "reverse, to face the other way" or "reverse, all whites marked to be black" or "all blacks marked to be white." Reversal in position is done by not turning the negative, when stripping it on the negative flat.

Color Plates on Zinc (Side notes 17 and 45)

The term "color plate" in this classification means a supplementary plate to print a color in conjunction with another, which is called a "key plate." These color plates can be made in any desired shape, and either solid or screened with Ben Day or other shading tints. They can be cut by hand and routed, or painted in and etched.

When they have to be made to register with any areas of the key plate, extra metal prints are made for them from the key plate negative, and all cutting, outlining,

painting in, or tint laying is done on these extra prints, one for each color. During these operations, any details of the key plate which appear in the extra prints, but which are not to show in the color plates, can be eliminated.

Key plates for this kind of color work can be either regular line plates, Ben Day line plates, or halftones of any kind, and there is no limit to the number of solid colors which can be added. Each color printed will require its own color plate, but as printing colors can be combined to produce others, it is seldom necessary to plan for more than three, or possibly four color plates, in addition to the key color.

Key plates can be either of zinc or copper, but it is usual to make the color plates on zinc, especially if Ben Day tints are to be used. If copper is desired for the color plates it will add to the cost, but this metal can be used if desirable.

Other than the extra operations required to paint in, lay tints, and cut special shapes, the mechanical operations for producing these sets of plates are the same as for others of the same classifications.

Chapter VII

Letterpress Engraving, continued

Extra Negatives, Stripping, Inserting,
Double Printing, Surprinting
and "Wash-Off" Prints.

VII

Letterpress Engraving, continued

Extra Negatives (Side notes 20 and 47)

The fact that several negatives can be cut and stripped together makes it possible to combine both line and halftone subjects on a single plate. There is practically no limit to the number of different negatives that can be combined in this way, and all those which are needed, in addition to the principal line and halftone negatives, are called "extra." The processes for making them follow the usual procedure.

Halftone negatives which have a flat, even, overall tone are called "tint" negatives. They are made by photographing a sheet of white paper, but because of the photographic principles employed in halftone photography, tint negatives can be of any desired tone from extremely light to almost black. Also, they can be made in any screen fineness. They are valuable in producing even tones of gray, even when printed with black ink.

Combining Negatives by Stripping, Double Printing and Surprinting (Side notes 21, 22, 48 and 49)

Line and halftone negatives can be combined by cutting and stripping them together on one glass flat, in about the same way that copies might be cut and fitted together. Combining negatives has certain advantages over the alternative of combining copies. First: each of

the negatives can be made of the proper size. Second: the thin films can be cut and joined more accurately than is usually possible in cutting and joining copies. Third: having the copies separated permits making clean line negatives with no confusing tones, and clean tone negatives with no confusing lines.

When two or more tone copies, such as photographs, are cut and pasted together, the different thicknesses of paper cause shadows which almost invariably show in the plate. These are very difficult to avoid. When two or more line copies are joined, the shadows become reproduced as solid blacks, called "paste lines." They can be removed from the plate, with additional finishing operations, provided they do not fall on other parts of the line work. When they do, their removal by hand may impair the cleanness or accuracy of the line areas which they have overlapped.

In stripping negatives together, each is laid on the glass flat in its proper position. If there is an overlap anywhere, both negatives are cut through at the same time and the unwanted parts of either are removed. Then the areas of the negatives to be joined or inserted are replaced in their proper position and they will fit because both were cut to the same shapes in one operation.

There are often instances, however, when the shapes and contours of the negative to be inserted are too complicated and involved to attempt cutting and fitting together. In such cases some method of "double printing" is used. One of these is "the ink print and wash off."

If the plate is to consist of two subjects, one of which is the principal negative and the other an insert, both halftone exposures are made in the usual manner. But a line negative is made of the insert copy, in addition to the tone negative.

Certain areas of this line negative may have to be painted in, until the entire insert area is sharp, accurately defined, and opaque. Then from this a line positive is made.

Employing both photographic and manual methods, this line positive becomes a clear transparent image of the exact shape of the insert, surrounded by an opaque black background.

When printed on the metal with the albumin solution, rolled up with ink and developed like a line plate, the entire "insert" area will be black ink. The surrounding background will be clean metal.

Then the metal is re-sensitized with the regular halftone enamel, covering the background and ink. The principal halftone negative is then printed in its proper position with relation to the insert subject, and the enamel print is developed.

The next operation is to gently wash this combined print with benzole, which will dissolve the ink print but will not affect the enamel print. As the ink washes away, the overprinted enamel image on it will wash away also, leaving clean metal precisely where the insert is to fall into position.

Then the washed-off print must be again sensitized with the halftone solution and the insert negative printed to fit into the space prepared for it.

When properly done the fit will be exact, regardless of the intricacy of outline or contours of the insert. After development and burning in, the plate is ready for etching.

In actual practice, considerable variation in method may be necessary, depending upon the nature of the copy, the amount of outline detail and its general tone.

Surprinting is used to superimpose the print from a

line negative on a previously made print from a halftone negative, or another line negative.

Line work which is on a tone copy will become screened when the halftone negative is made.

Line work made on a separate copy will be solid, with no screen, when it is surprinted on a halftone print.

The surprinting operations are to coat the metal and make the print from one of the negatives. After burning in slightly to be sure that the print will hold, the metal is coated again and the second print is made on top of the first one. After development of the surprint, the plate is completely burned in and is ready to be etched.

Surprinting from line negatives produces solids, so care should be taken to be sure that any halftone areas, on which the line work is to be placed, are sufficiently light to let the line work show. Line surprints on very dark areas of the halftone print may be almost invisible.

Surprinting must always be done before the plate is etched and it is never used to produce white lines.

When whites from line copy are to be etched into any halftone area, it is done either by the ink print and wash-off process, or by stripping. The wash-off is used more for color plates than for black and white, because it assures better register when the whites are etched into more than one plate of a color set.

When using the stripping method, a line negative is made of the proper size to fit the space provided for it in the halftone area. If the line copy is black on white, then a positive must be made from it. If the copy is white on black, like a negative photostat, then no positive need be made.

After the halftone negative has been stripped on its flat, the line positive is stripped on top of it in its proper position. All of the blacks which are stripped on a halftone negative will act as an opaque mask and they will block out the screen so effectively that, when the combined negative and positive are printed on the metal, there will be no screen whatsoever in the areas that are to be etched white. The overall size of the positive must be slightly larger than that of the tone negative on which it is to be stripped. A small patch stripped on would show its edges in the etched plate.

A good way to identify the difference between the supplementary methods for producing either blacks or whites is to remember that blacks are always additions. They are either surprinted or painted in. Whites are always the result of something taken away, either by stripping blacks on the negative to act as masks, or by washing off. After plates which have screen in the whites have been etched, the removal of this screen must be done by tooling, and perhaps routing, or the surrounding areas must be painted in so the whites can be etched out.

Stripping a tone negative on top of a line negative is also used to produce screen effects in line solids. This is sometimes called "overlining," and it is extensively used to produce screen tints in plates from solid line copy. It must be done before the plates are etched.

To understand this method, it is only necessary to recall that the black lines of a line copy will be transparent in the line negative. The white paper of line copy is opaque in the negative. When a halftone negative is stripped over a line negative, its screen formation will be printed on the metal *only* through the clear transparent parts of the line negative. If a halftone negative is stripped on top of a line *positive,* there will be no screen formation in any areas of the positive which are black; it will only print through to the metal where the areas of the positive are clear and transparent.

When only certain parts of a line negative are to be screened, the tone negative laid over it must be cut, and parts of it removed from any line areas which are not to be screened.

In principle, the stripping of a tone negative on top of a line negative is the same as laying a Ben Day tint on the negative, although the method is different.

Chapter VIII

Letterpress Engraving, continued

Outlining, Vignetting, Special Finishes, and Process Color Work

VIII

Letterpress Engraving, continued

Outlining, Vignetting, Ovals, Circles and Round-cornered Halftones (Sides notes 23, 24, 50 and 51)

It is characteristic of the halftone process that screen appears overall when a regular halftone negative is made.

Removal of screen from some areas but not others has to be done by hand, on the etched plate, or by painting out the screen on the negative, before the metal print is made.

When done on the plate, the method is called "outlining" or "silhouetting." The engraver tools a thin white line in the metal, separating the screen areas to be removed, from those which are to be held. The router then cuts away all unwanted areas, working up to the center of the white line that has been cut. The slight shoulder of metal around the routed areas is then trimmed off.

If the shapes to be silhouetted are complicated in detail, it is usually better to paint in the areas to be held and then etch the screen away from the unpainted parts. This is called "painting in and dropping out." Silhouettes can also be made by any of the "highlight" processes.

Good, sharp silhouetting requires that the outlines of the copy to be followed must be clearly defined. Frequently this will mean that the copy will have to be retouched, by painting in a white guideline to indicate the silhouetted shape wanted. While this white line will not

actually silhouette the plate itself, it will serve as a guide to be followed in the silhouetting operations.

Painting in, or "opaquing" the negative, will also produce silhouettes and the same effect can be obtained by stripping a line negative over the screen areas which are to be dropped out. When the latter method is used, it is often necessary to prepare a black "mask" which will register exactly with the copy areas to be eliminated. A line negative from this mask, made to fit the screen negative and then stripped on, will drop out whites accurately.

"Vignetting" is a form of outlining which produces a soft "fadeaway" edge. Copies must nearly always be retouched with the soft effect desired, otherwise it is difficult, if not impossible, to obtain the proper gradual disappearance of the screen dots.

After the plate has been etched, the engraver outlines the extreme edges of the areas to be faded away, in very much the same manner as the plate is tooled for silhouetting. But then the screen dots must be re-etched in graduating tones, so that those on the outer edges of the vignette will be reduced to the finest possible point. After this is done, the plate can be routed like a silhouette, working only up to the tooled lines which establish the extreme edges of the fadeaway.

Vignetted plates require special treatment on the press when they are printed. They require what is called a "make-ready" to reduce the printing pressure on the extreme outer edges of the vignetted areas. Printing which has to be done with no make-ready will not produce soft vignettes.

Ovals, circles and round-cornered halftones are all made by some silhouetting method. For the best results a line scheme or mask of the shape desired is made; then

a line negative from it is stripped over the tone negative. This is probably the shortest way. These plates can be cut to shape by a skilled operator, but it takes time and never is quite as photographically sharp and accurate.

Process Color Work *(See Color Scale for Side Notes)*

Process color work, although much more elaborate in detail than any other branch of the industry, follows the principles which have been described in this article, except in photography.

When copies are in color, a photographic method called "color separation" will be required. This is in addition to the screen or line negatives which may be needed.

Color separation is a necessity, because the colors in the copy are all combined in one picture. But as each plate of a color set can print but one color at a time, a separate printing plate must be made for each color to be printed. Color separation by photography makes this possible.

In two-color process work, any two colors can be used which will best reproduce a two-color copy. For the most accurate reproductions by this method, the copy itself should be prepared with the same two colors.

In three-color process, the copy can be in full color, but the printing colors will be yellow, red and blue. These three colors can be combined to make many other colors, including black.

Four-color process plates print in yellow, red, blue and black. The first three produce the foundation for the basic color reproduction and the black is used for type matter, for solid blacks and grays, and to make some of the combined three colors darker and more neutral. In

some instances the fourth color can be gray, or even another blue, usually of a deeper shade than that used for the basic blue printing color.

In making process color plates, every copy must be photographed through "color filters," once for each *printing* color to be used. The ink colors used in three-color process work are yellow, red and blue. In four-color they are yellow, red, blue and usually black. These colors are scientifically determined so that in their various combinations they will reproduce practically any others.

The filters used in color separation photography are complementary to the printing colors.

The violet or red-blue filter is used to make the yellow separation. This filter allows all of the red and blue colors of the picture to pass through it and after exposure on the photographic plate and subsequent development they become the *darker* areas of the color separation negative. When a print from this negative is made, all of the red-blue colors of the original will be light. The yellow values will be darker. This will be used to make the yellow printing plate.

A green or yellow-blue filter, operating on the same principle, will lighten or eliminate all yellow and blue color values, leaving the red values strong. This makes the red printing plate.

An orange or red-yellow filter is used in a similar manner to make the blue printing plate.

The black plate is made by using a special yellow filter. At best, this "separation" is a compromise and may require a considerable amount of handwork on the plate.

Although yellow, red and blue can be combined to make black, the commercial requirements of the color process in publications makes the fourth, or black plate, necessary, especially for type matter.

The filter and ink colors are given below in simplified form:

Filter: Red-Blue (Violet) Complementary Ink: Yellow
Filter: Yellow-Blue (Green) Complementary Ink: Red
Filter: Yellow-Red (Orange) Complementary Ink: Blue

Color correction in separation negatives is an intricate and involved process and many different methods are employed. It is necessary because of the way different color plates are made; the kind and color paper on which they are printed; and the type of press used and its printing speed. Corrections made in the photographic part of the process may save a considerable amount of handwork later during the etching and re-etching of the plates themselves.

Color separation by a new electronic scanning method is being developed. *Life* recently published eight pages of color entitled "Spring in the Desert," the color separations for which were made by this new method.

Each plate must have the proper "screen angle" so as to avoid screen patterns when one impression is made on top of another. It is done by turning the screen in the camera or by turning the copy to its proper angle as each negative is made.

Considerable staging and finishing is required in color reproduction, to give each printing plate its proper color values. These values are not only important in themselves, but especially so when they become combined with the color impressions from other plates of a color set. Each plate prints only the color for which it was made, but when they are all combined by printing the separate impressions one on top of another, in exact register, the colors of the copy, which were separated into their "process" color values, become reconstructed by the manner in which the printing colors combine.

Proofs *(Side notes 26 and 53)*

Engraving proofs, in either black and white or in color, are usually made on the cylinder type of proof press and on the same kind of paper as will be used to print them. Most proofs are made from unblocked plates. In many instances the bearers of dead metal surrounding the printing areas are allowed to remain on the plates, but they are covered up with masks or "friskets" which prevents their appearing in the finished proofs.

Finished plates can go to the printer either blocked on wood to make them type-high, or unblocked, with or without bearers. The decision rests with the printer who usually specifies how he wishes the plates delivered.

Blocked plates very often have to be made flush on one or more sides to permit placing type matter close to the printing area of the plate. Sometimes the blocks are notched or mortised to permit type matter to be inserted. Plates that are to be flush blocked all around must be "anchored" to the blocks with soldered metal projecting into holes in the blocks, or they can be flush mounted with adhesives and then they require no anchors.

Although copper and zinc are used extensively for letterpress engraving, there is no reason why other metals and alloys cannot be used if they are suitable.

Chapter IX

Platemaking for Lithography

Although these processes are also flexible and versatile, no responsibility for their production rests with the buyer. Technical details are taken care of by the lithographer, but it is advisable to consult with him, before copies are selected or prepared.

IX

Platemaking for Lithography

Lithography on stone, on sheet metal, or when printing by the offset method, uses both halftone and line negatives, and the distinction between tone and line copies is the same as in letterpress. But there is *not* the same need for selecting either coarse or fine screens to suit the paper and printing conditions. The screens used in this process seldom are coarser than 120 or 133 lines, but they may be finer.

When lithographic printing is done from either stone or metal, directly to the paper, then line or halftone *negatives* can be used for platemaking. If the printing is done by the offset method, the negatives need not be "turned." The prints from them will "read right" on the plates; they will become reversed when the impression is made on the blanket of rubber; and they will read right again when this rubber blanket impression is "offset" on the paper.

When the method is "deep-etch offset," positives must be used instead of negatives.

Material used for lithographic platemaking usually must have a grained surface to aid in holding the proper amount of water moisture required in inking and printing but with some of the new bi-metallic plates the grain is not necessary. When printing from line or screen negatives, the plate surface is sensitized in much the same way that zinc plates are made for letterpress. The print is rolled up with litho ink and developed in water; at this

stage it is practically the same as an "ink print," but it does not have any topping powder added to it, as the required "resist" in this process is in the ink.

Instead of an etching bite to deepen spaces between lines or dots, the plate is delicately etched with a weak acid solution, just enough to open up the spaces between the granulations of the metal. The purpose of this slight etch is to help the non-printing areas to hold water moisture. After this etching, the plate is "gummed" with a thin solution of water and gum arabic. The water in this solution helps to prevent its adherence to any ink areas, and the gum in it makes it more receptive to water and also delays evaporation.

On the press, two sets of rollers are required: one set for water and the other for ink. These plates can be printed directly to paper, or used on offset presses.

For deep-etch offset, the sensitizing solution is somewhat different; it is sensitized gum, and the printing on the sensitized metal is done from positives. After rolling up with the ink and developing, the ink print will be *negative,* as it has been made from positives. This means that every line or dot *eventually* to be printed will be represented by clear, open spaces. In between, however, there will be areas of the ink print. At this stage, the non-printing areas have an ink covering while the printing areas are clear. But the next operations will reverse this.

The print is now in condition to give the printing areas their "deep" etching. To do this, the thin film of gum on the open spaces is cleaned off and the plate is etched to a depth of perhaps half a thousandth of an inch. This depth of etching is not nearly as great as is required for letterpress.

The next step is to roll up the whole plate with the regular lithographic printing ink. This will fill in the

deep etched lines or dots and at the same time it will add more ink to those areas to which the ink of the print still adheres. But these parts of the print have a thin film of gum under them, and by washing gently enough of this gum is removed to remove the ink on it. This last operation has no effect upon the ink in the deep etched parts, for these have no gum under them; and as they are grease ink areas, water does not disturb them. During this final wash-off, enough gum must be allowed to remain in the non-printing areas to accept the water moisture.

The print will now be "positive," as the negative values have been reversed in the double inking and washing-off steps, and the job is ready for the press.

Photographic printing on litho plates can be done in a printing frame such as is used for photoengravings, from assembled or set-up negatives or positives; or the metal print can be made in a "step and repeat" machine. This is a precision instrument by means of which individual subjects can be printed or repeated in any desired position on the sensitized metal, with perfect registration. It is lithography's equivalent of the electrotypes used in letterpress.

In some lithographic methods, duplication is achieved by making "transfers." An ink impression is pulled on transfer paper, from a master plate. Because of the nature of this paper, enough ink is carried on it to permit of a duplicate impression being made from it onto the final printing plate. Hand work can also be done with litho crayon on transfer paper and some pictorial artists make their drawings on this kind of paper. The reproduction of such a drawing requires no photography; the transfer is made directly to a printing plate and the subject can then be printed lithographically. The final impression will,

of course, be the same size as the drawing. Any change in size would call for the aid of photography.

After the prints have been completed and are ready for the press, relatively little corrective work on them is feasible. Any corrections, such as those accomplished in photoengravings by re-etching or burnishing, are done by lithographers on their negatives or positives, before the metal prints are made.

All of the matter to be printed by the lithographic process in any single color is made up as a "form" of either negatives, positives, or both. Then the complete set-up is printed on a single metal plate. When the plate is finished, no changes of position can be made. When the step and repeat machine is used, the printing of each piece in its proper position on the metal takes the place of "setting-up" negatives and positives as a form.

Lithographic plates can be made in any size which the presses will take. The maximum at present is 50″x72″.

Chapter X

Platemaking for Gravure

As in lithography, the manufacturer takes care of all technical details incident to platemaking for these processes.

X

Platemaking for Gravure

Printing plates for "sheet-fed gravure" are of thin polished copper, and must be tightly clamped to the plate cylinder of the press for printing. For rotary gravure, in which the printing is usually done on a "web" or continuous band of paper, the printing pattern can be etched into the surface of a copper-covered cylinder; or the thin metal plates can be used instead.

These methods both employ positives rather than negatives. They can be "screenless" or "continuous tone" positives, or they may have a special screen formation, somewhat (but not entirely) like that used in letterpress or lithography.

When using continuous tone positives, the gravure screen required in the plate finds its way into the picture by a double-printing operation. This type of screen does not have crossing black lines like the halftone; it consists of tiny black squares, separated by thin crossing *transparent* lines. It is called a "positive" screen.

After the various positives have been assembled in their proper position on a transparent backing, the first step in platemaking is to print the screen on sensitized carbon tissue. This is a sheet of heavy paper coated with a film of gelatin. It becomes sensitized by immersing the whole sheet in a sensitizing bath and hanging it up to dry.

When the screen is printed on this sheet, the light that passes through the *transparent cross lines* affects the gelatin in such a manner as to make it insoluble in water.

It creates a grid of thin crossing lines, but the squares between these lines remain unaffected because of the black squares in the screen.

After the screen print has been made, the positives are surprinted directly on it. The intensity of the light passing through these positives will vary with their different densities, and the effect on the little squares, which have heretofore remained unaffected, will be to give them different degrees of insolubility.

On completion of the double print, and before any developing is done, the exposed side of the sheet must be evenly wet with water and immediately squeegeed under pressure to the surface of the copper plate, or to the surface of the cylinder, paper side out.

When thoroughly dry, development is done in warm water. The paper backing comes off first and then, slowly and with the utmost care, the *soluble* gelatin is washed away. There is a pigment mixed with the gelatin, so the operator can see the progress of the development.

When the print is completely developed the coating on the metal will be little raised square dots of gelatin which vary in thickness. These variations will represent the strength or weakness of the light to which the coating was exposed during the double-printing operations through the positive screen and through the "tone" positives, and each tiny square will be separated from its neighbor by the screen crosslines.

Etching is done *through* these different thicknesses of gelatin.

The acid solution will pass through thin areas faster than through the thick ones, and the final result will be tiny cups etched into the metal, and these cups will vary in depth. Those which are in the lightest parts of the pictures will be quite shallow, because they had the

thickest protective film of gelatin on them. Middle tones will have deeper cups, and shadows will have the most depth.

The crosslines created by the screen will not be etched at all, and they will serve to establish thin walls of metal separating each of the tiny squares.

The ink used in printing gravure plates is quite fluid. It is carried in a trough on the press, and the printing cylinder rotates, with a small segment of its surface buried in this ink. The etched cups become filled, but before the impression is made on the paper, the excess ink on the surface is cleaned off by a thin "doctor blade," and falls back into the ink trough, leaving in each cup the amount of ink permitted by its depth.

On some presses the ink is forced into the ink cells by pressure, as well as dipping the cylinder into the ink trough.

The printing impression squeezes the paper into these ink cups, and when it comes out ink comes along with it. Deep cups carry more ink; shallow ones carry less. That is what produces tonal variations in gravure.

The gravure processes always use fine screens; not less than 150 lines and frequently 175 and 200.

There are three modifications of conventional gravure. One is the News-Dultgen method, another is Intaprint, and the third is the Henderson process.

The Dultgen process uses a special type of halftone screen positive, in which there is a considerable variation of dot sizes. By a double-printing operation on the carbon tissue, these dots also become covered by a gelatin film of varying thickness, as in regular gravure. Consequently, the printing values of the plates have dots which not only vary in size, as in a halftone, but they have a variation in depth as well, as in gravure.

One of the advantages of this method is that the doctor blade bears on greater areas of high metal, rather than on the thin crosslines of the grid, and there is less tendency to wear the plate during long-run high-speed printing. The variations in dot sizes, as well as in etched depth, gives a double control of color values.

Intaprint also uses screen positives which have considerable variation of dot sizes, but it does not employ the carbon tissue feature. The metal is sensitized as for a copper photoengraving and burned in. One acid bite gives the printing dots their required intaglio depth.

The Henderson process, like Intaprint, is a "reverse" halftone screen process using a sensitized enamel top in place of carbon tissue.

Color plates for any of the gravure processes utilize the color separation methods employed in both letterpress and lithography.

As very little corrective work can be done on the plates or cylinders after they have been etched, a considerable amount of hand work or retouching may have to be done on continuous tone negatives or positives, before they are printed.

Chapter XI

Typesetting

Although typesetting is not an engraving process, every piece of type cast by any method, requires an engraved matrix which makes the type-casting possible.

XI

Typesetting

The processes of engraving and platemaking which use photography are essentially reproductive. They do not pretend to create any graphic forms or designs; they simply reproduce the copy, whatever it may be, by means of photography and the allied arts of etching and engraving.

But there is another art which in a sense *is* creative; it is "typesetting" or "composition," by means of which separate letters, numerals and other characters can be assembled and from them the "written word" can be printed.

A type character is a small squared bar of type metal, flat at its base and having at the other end a letter or other character in relief. Every piece of well-made type is identical in size from its base to the top of the relief character. This dimension is called "type-high" and is .918″. This uniformity in size permits the assembly of any number of separate characters and printing them all together at one time.

Type characters are available in many different sizes and the larger the face of the letter, the larger the type body which supports it. The size of a type body, measured from north to south as you look down on it, is designated by the "point" system. 72 points are almost exactly 1″, so if a type body is "6 point" it means that the body itself is nearly $6/72$″ or $1/12$″ in thickness. This does *not*

indicate the size of the type *face;* it applies to the north and south thickness of the body only.

Precision accuracy in the point sizes of type bodies is just as necessary as in their type-high size. Otherwise the characters would not line up when they are assembled side by side.

The width of the body, from right to left, may vary considerably. Narrow characters such as "l" and "i" have thin bodies; letters such as "a," "b" or "c" have wider bodies, but they are not necessarily uniform.

In the older types the small letter "m" was on a square body, and from this came the custom of indicating the width of a line of type in "ems." It was found confusing and cumbersome to designate sizes in "6-point ems" or "10-point ems" or any other variations, so the 12-point em became accepted as the standard unit of measurement for the width of type lines.

The 12-point em is also called a "pica." Six 12-point ems or 6 picas will measure 72 points or .996″.

Pica rules are used in all print shops and if a comparison is made between one of them and a standard inch rule, the difference in 1″ can hardly be noticed; but in 10″, 60 picas will be seen to be slightly less, 9.96″.

If "picas" are designated for the width of lines, it can be taken to mean that there are 6 to the inch. Instructions to set a line of type to "15-em measure" or "15-pica measure" means the same thing. The line will be nearly 2½″ wide. But in critical measurements, if the *depth* from top to bottom is specified as being so many "picas," then the pica rule may have to be used.

The use of the point system permits accurate calculation when employing different sizes of type bodies. Based on 72 points to the inch, it will be seen that when using 6-point type, there will be 12 lines to the inch; with 8-

point type there will be 9 lines to the inch; with 12-point there will be six.

Type set in this manner is said to be "solid." If more space is desired between lines, it can be obtained by inserting spacers called "leads." These spacers are thin, flat strips of lead and they are usually 2 points thick. They are not type-high but come up only to about the height of the shoulder of the type body.

If type on an 8-point body has been set solid, there will be 9 lines to the inch. If a 2-point lead is inserted between the lines, there will be only 7.2 lines to the inch as the 2-point lead, in effect, increases the body of the type from 8 to 10 points. But it gives 2 points more space between the lines. One-point leads are also available, when required.

Another term used to designate the depth of columns of type is the word "lines." This in an inheritance from the days before the point system came into use and it refers to a very small size of type known as "agate." There are 14 agate lines to the inch.

Agate line measurements invariably apply to the depth of a column; never to the width or "measure" which is always in picas or ems. It is extensively used by newspapers and periodicals.

Newspaper advertising is usually sold on the basis of the number of lines in the space. A single column advertisement 10″ deep would be 140 lines of space. A double column of the same depth would be 280 lines of space.

Type can be set by hand or machine. When set by hand it is called "hand composition."

For hand composition, the type is distributed in "cases," which are like large trays having numerous small subdivisions; a separate one for each letter or character. From these compartments, the compositor selects the let-

ter he wants and places it in a composing "stick." This is a small metal tray with fixed walls at the top edge and one end. There is another wall, but its position is adjustable. The fourth side of the frame work is open.

The compositor holds this stick in his left hand with his thumb in the opening. Each piece of type is set into this frame, one after another, and held in place by the compositor's thumb. When the line fills the width of the stick it must be "justified" by more or less spacing between the words, until it just fills. Then the "comp" begins on the next line.

When the stick is full, which will be approximately 2″ in depth, the whole block of type is transferred to a longer tray called a "galley." Galley proofs are those made from a full galley of type.

For convenience and ease of operation, the cases of type for hand composition are placed on racks at a convenient height. The small letters, numerals, punctuation marks and work spaces are all in one case directly in front of the compositor and at about the height of his elbow. The capitals, both large and small, may be in another case which rests on a slanting support of the rack just beyond and slightly above the case which contains the small letters.

The position of these cases, one "upper" and the other "lower," has given the capitals and small letters their descriptive names; upper case and lower case. Capitals of the full size are known as "caps." The smaller capitals, which have a depth of face equal to the depth of the small letters such as "m," are "small caps" or even "s.c." The small letters are "lower case," "lower" or "l.c."

In type used for hand composition, the numerals are on an "en" body, which is exactly half an "em" in width. This uniformity in width of the body permits accurate

alignment vertically, bringing each numeral directly under the one above it in the column.

Knowing that the numerals of say a 12-point type are each on a body exactly 6 points wide makes it comparatively easy to determine the space which must be allowed for figures in elaborate tabular composition, or what size of type may be used to fit within a given space.

Type which has a face simulating typewriter type is also on bodies of uniform width, the purpose being to copy, as nearly as possible, the effect of the uniform spacing of typewriting.

To a very large extent, modern typesetting is by machine; such as Linotype, Intertype or Monotype. The machines have a keyboard somewhat like that of a typewriter.

In the Linotype or Intertype, pressure on a type key brings a "matrix" of that particular character into position. Each matrix is a small flat piece of metal with the type character engraved into one edge. These characters are "intaglio"; they are sunken, reversed duplicates of the type character which is to be cast from them. As each key is pressed, a new matrix comes into position to spell out the words or to supply the other characters called for by the operator. When the line is full, it is automatically "justified" with spaces of the proper thickness between the words and then the operator moves the line to another part of the machine which makes a type metal cast of the whole line in one "slug."

Each matrix has a different series of identifying notches and after the cast has been made, the machine "reads" these notches and returns each "mat" to its proper place in the type magazine, to be used over again.

An adjustment of the casting device enables the operator to regulate the thickness of the slugs. Thus a 6-point

type can be cast on either a 6-point body, or it can be increased to other thicknesses without effect upon the type face itself. This affords means for increasing the spacing between lines, without the use of leads.

The size of the type as well as that of the body is indicated by the terms: "6 on 7" or even "6/7" which means 6-point type on a 7-point body.

After the slugs have served their purpose, they can be melted and reconverted into ingots of casting metal for use over again.

In the Monotype machine, the operation of the keyboard perforates a roll of paper, much like a music roll in a player piano. When the roll is completed it is put on a casting machine which moulds each type character separately and places it in position as in hand composition.

The size of the type body can be regulated in this method also, and the used type can be melted and reconverted.

In addition to the machine-set metallic types, there are machines and methods for "photo-composing," and "photo-lettering." In these processes the "font" of type is a photographic negative. Printing is done one character or one line at a time on sensitized photographic paper. The finished result looks like hand or machine-set type printing but it cannot be used for printing until it has been photographically reproduced by one of the engraving processes.

Type sizes are always designated by "points." The usual standard sizes are: 6, 8, 10, 11, 12, 14, 18, 24, 30, 36, 42, 48, 60, and 72 points. These are the sizes of the type bodies, not the faces.

There are innumerable different type faces and many of them are supplied in most, if not all, of the foregoing body sizes.

Considerable practice and experience is necessary to determine the type size which will fit into a given space.

There are different tables, type rules and other devices such as those in the Production Year Book to enable one to make the necessary calculations, but in the absence of these labor-saving gadgets, a "character count" will serve for a good approximation.

Utilizing a type specimen book, or any other adequate sample of the style and size of letter which it is planned to use, count the number of characters in a line of any given length.

For example: If the line counted has say 48 characters and is 4″ (24 picas) long, the average will be 12 characters to the inch. Then count the characters in the matter which is to be set. This will require counting several lines and striking an average, because handwritten or typed lines are not always of the same length. If 10 lines of matter count up to 480 characters, it will be pretty good evidence that the matter can be set line for line with the type selected which also has 480 characters to every 10 lines.

If the type selected happens to be 12-point, set solid, there will be 6 lines to the inch in depth. Counting 48 characters to the 24-pica measure will indicate that this type will set 288 characters to every inch of depth.

By counting the total number of characters in the matter to be set, it will be relatively simple to estimate the total depth in 12-point solid type if the 24-pica measure is adhered to.

But if the measure is changed, or if the space between the lines is to be increased, a whole new set of figures must be prepared.

For instance: Suppose the measure is to be 3″ (18 picas) instead of 4″. There will be only 36 characters to

each line instead of 48. In 1″ of depth, or 6 12-point lines, the total will be only 216 characters. If, to obtain more space between lines, the type set is the same 12-point selected but on a 14-point body, there will be only $5\frac{2}{14}$ lines to the inch instead of six.

The use of counted characters instead of counted words is advisable, as the length of the words may vary considerably in different writings.

To count the characters, simply add up the letters, punctuation marks, numerals and spaces between the words and sentences, and it is well to bear in mind that some type faces are more condensed than others and the number of characters to a given measure will vary, even though the type may be of the same body size.

Letterpress is the only one of the three processes that permits printing directly from type. In both lithography and gravure, reproduction proofs must first be made from the type; then these proofs are used as "copy" for plate-making. They can be photographed like any other line copy or the proofs can be made on a suitable transparent material and used as though they were photographic line positives.

Chapter XII

Electrotyping and Stereotyping

Duplicating Processes for
Special Press Requirements

XII

Electrotypes and Stereotypes

Although letterpress printing can be done directly from type, it is often advisable (and in some instances necessary) to use electrotypes or stereotypes made from the type.

The type used for hand composition is cast from a metal alloy which consists of lead, tin, copper, antimony, and other ingredients. It is subject to wear when used for printing. When redistributed into its cases the worn letters become mixed with others that are clean and sharp, and when another job is set up the worn faces will look heavier than the others. Many printers and trade compositors refuse to permit quantity printing to be done from their types.

The type set by Linotype or Monotype machines will also wear, but when the job has been run the type is not redistributed but is melted down and recast into bars for use again in the machines.

Presses which print from curved plates cannot use either hand or machine-set type on their cylinders, so curved electros or stereos must be made from the type when these presses are used.

Electrotyping also makes it possible to print the same matter in many different publications without re-setting the type or making new original engravings, and also to print, in large forms, many duplicates of the same originals, for economy in press work.

Electrotypes are duplicates of type forms or of letterpress plates.

They are made by electroplating a mould of the forms, which gives a "shell" of very thin metal, which, on its face, is a duplicate of the form which has been moulded. The shell is then backed up to proper thickness for final finishing with a lead alloy.

Stereotypes are also made from a type of mould called a matrix or "mat," but in this process the mat is not electroplated. The final printing plate is made by making a type metal casting of the mat.

When an electro is to be made from a form of type, the form must first be locked up securely in a heavy metal frame called a "foundry chase." Surrounding the type matter, and as close to it as possible, there must be "bearers." These are narrow strips of type-high metal. Large open spaces in the form must also have type-high bearers.

After a thorough cleaning, the locked-up form is evenly coated with a thin covering of black lead. This must be so perfectly applied that it covers every area of the surface and into all depressions, but at the same time it must not fill them up. After this the form is ready for moulding.

Moulds can be made in wax, specially prepared sheet lead, or in a plastic called Vinylite, by forcing the prepared form into the moulding material in a heavy hydraulic moulding press. Wax moulding is done on "cases" which are sheets of copper, evenly covered with a special wax coating, shaved to perfect smoothness. Several hundred tons of pressure are required to squeeze the form evenly into the wax. This pressure causes the material to fill in every low area of the form and the type-high bearers help to confine the wax to the areas which are to be moulded and prevent leakage sideways.

Moulding in lead requires a great deal more pressure than wax, and it cannot be used for direct moulding from type or blocked engravings combined in one form. Electros of the type should first be made, shaved to 16 gauge thickness and these "gauge electros" are then incorporated with unblocked engravings. From such a pattern, lead moulds may be safely made.

Vinylite moulds require relatively little squeeze, as the material is hot when the pressure is applied. Another advantage is that in this plastic moulding the form need not be black leaded.

After the required pressure has been applied, it is released and the mould is carefully removed from the form. In the wax and lead moulding processes, the coating of black lead prevents the form from sticking, and if it has been properly made, the mould will be an intaglio replica of every character in the form.

Relief printing plates of any kind can also be moulded. In fact, type and printing plates can be locked up together and all moulded at one time in either wax or Vinylite. Bearers are also required on plates to be moulded; were it not for these bearers, the moulding material might flow along the path of least resistance and fail to properly fill in some low spots of the form, causing an imperfect mould.

A difficulty sometimes encountered when moulding from etched relief plates is due to "undercutting." When a plate has been improperly etched, the acid may have bitten into the metal under the surface of its lines or dots, as a river undermines its banks. When such a plate is moulded, the material of the mould will be pressed firmly into these hidden hollows and the mould will lock to the form so firmly that it may be torn or seriously damaged when it is removed.

After a wax mould has been properly made, the next step is to coat it with a very thin film of polishing lead to make it electrically conductive in the plating bath; Vinylite moulds are coated with silver for the same purpose. Lead moulds need no preparatory coating as the material is electrically conductive.

At the start of the electroplating operation, nickel is often used for the initial deposit, and then the shell is finished up with copper to the usual thickness. This gives a nickel face to the plate and more resistance to wear. It is customary to call these "steel-faced electros."

The plating done with copper is deposited very slowly and evenly, to assure the deposit's reaching every tiny depression in the mould. When the electroplated deposit is about .015″ thick, the mould is removed from the bath and the deposit can be removed. This is called a "shell" and its thickness can be controlled by the length of time the mould is left in the plating bath.

The face of an electrotype shell is practically an exact duplication of the original from which the mould was made, but the back is somewhat rough and the shell is too thin and fragile to be used for printing until it has been backed up.

Backing-up is done by laying the shell face down on a hot steel slab, surrounded by a metal "dam," and pouring molten backing metal of lead, tin and antimony on it to a thickness of about $\frac{3}{16}$″. When the backing cools and solidifies, the face of the plate is leveled up to remove any low spots caused by the heat, and then the metal backing is shaved in a planer to a thickness of 11 points, or .152″ or whatever thickness is specified. The edges are then trimmed for mounting on a wood block or beveled for patent bases if so ordered.

Frequently, electros are required to be the same gauge

as the metal used for photoengravings. This is accomplished by planing the backing metal to 16 gauge thickness. The plate is then called a "gauge electro."

A patented backing-up process consists in electroplating the shell to a thickness of more than $\frac{1}{16}$″ to make a solid copper sheet. Then the back is planed down in a special lathe to exactly 16 gauge. No lead backing is used and the process is generally employed to duplicate color plates which are to be run in more than one publication, and when ordinary electrotypes are not acceptable. These can be used for either moulding or printing in place of originals. They are often known by trade names given them by the electrotypers licensed to use the process.

When the printing process calls for curved plates, lead backed electros can be used because of the ease with which they can be curved to fit the printing cylinders.

Stereotypes are type metal castings made from mats. There is a considerable variety of material used for making stereotype mats, but they are similar in one respect: they do not melt or burn up when the molten casting metal is forced into them. One reason for this is, that the molten metal is forced into complete contact with the mat so quickly that practically all the air is driven out of the space between mould and metal.

The material used for stereotype moulding is supplied in large, flat, flexible sheets, somewhat like smooth blotting paper. Their size permits the moulding of a full-sized newspaper page. The casting made from the mat is a "stereotype," usually abbreviated to "stereo."

When the casting is made from a flat mat, the plate is known as a "flat stereo." Stereotypes cannot be curved after they have been cast, but the mat can be curved first, in a casting box of the correct size and curvature, and the stereo will then have the correct curvature for the press

on which it is to be used. Both the flat and curved stereotypes are planed to proper thickness after they have been cast.

Because of their metal backing, electros are comparatively heavy and a shipment of a considerable quantity may involve a good deal of expense. Shells are often shipped unbacked, to be backed up and finished after they reach their destination.

Another style of plate used extensively by newspapers is made from a plastic material. A mould is first made in Vinylite, coated with silver and electroplated in the usual manner. The shell is backed up, finished to an absolutely level surface and shaved to thickness. At this stage the plate is called a "master pattern."

The next operation is to make a new heat-resisting plastic mould from this master pattern and the final plate is made from this, using a hot granular plastic vinyl resin powder under pressure, which converts the powder into a solid plastic plate. The result is a printing plate of much lighter weight than either an electrotype or stereotype.

The need for the preliminary electrotyped pattern is to permit leveling up any undesirable inequalities in the surface of the form. The final plastic plate cannot be leveled after it has been finished.

Mats can also be shipped to newspapers and publications which have facilities for making their own stereotypes.

Mats of less than a complete full-sized stereo, as required by the press on which it is to be used, must first be cast as "flat stereos." These plates are imposed in the page form and then the final stereotype is made. This results in a stereo from a stereo, and there is a possibility of a good deal of loss in quality and printing depth.

A similar difficulty arises when electrotypes of photoengravings are sent to publications which re-electrotype them for press use. Some publications, therefore, will accept only originals, or their equivalent, made by the special processes which produce the 16 gauge electrically deposited copper.

Electrotypes and stereotypes are used only in the letterpress printing process. In lithography and gravure the step and repeat machine or the setting up of duplicate negatives and positives takes the place of electrotyping.

Chapter XIII

Presses and Printing

Letterpress

XIII

Presses and Printing, Letterpress

Primarily, the purpose of a printing press is to afford the pressure needed to make a printed impression from an inked form. But modern presses are designed to do many other things.

They must handle the paper, ink the forms, print them on one or both sides of the paper in one or more colors and, perhaps, cut and fold the printed paper into signatures before it leaves the press. They must do all of these things automatically, and at high speed.

The gigantic machines which perform this complete series of operations are the ones we see in big newspaper and publishing plants, but there are others much less complicated, such as the little one that can be purchased in a toy store for a few dollars and which is just large enough to print a business card.

Printing presses, like the processes themselves, are divided into three groups: letterpress, lithographic and gravure. Of these, letterpress has by far the greatest variety.

Letterpress Printing

Letterpress machines are known as "platen," "cylinder" and "rotary" presses.

A platen press prints the entire area of a form in one flat squeeze.

The cylinder press prints from a flat form, but the

paper is carried around an impression cylinder and the printing impression is a continuous rolling squeeze.

The rotary press carries the printing form on a cylinder and the printing pressure is exerted against another cylinder. The paper feeds between these two.

The pressure required to print a whole form in one flat impression limits the size of platen presses. Cylinder and rotary presses can handle much larger forms, because the printing pressure is exerted in a rolling motion and only a very narrow strip of the printing area comes into contact with the impression cylinder at a time.

Platen presses are constructed in many different designs, but the style in most common use opens and shuts like the front and back covers of a book. It is sometimes called a "clam shell" press. The form is on the back part, the platen is a flat steel slab at the front and the paper goes in between. The platen is hinged on a heavy bearing and the squeeze is created by a pair of arms at the sides which pull the front and back sections together. These presses can be sheet or web fed; the separate sheets can be fed into the press by means of automatic feeders.

The printing form of type, plates, or both, is locked up in a metal frame called a "chase" which is clamped to the bed or back part of the press. The platen is covered with a press board and paper packing, tightly drawn over the metal slab, but affording slight resiliency to equalize slight inequalities which may exist in the printing surface of the form. When properly tight, the top sheet of this packing is like a drumhead, from which it gets its name of "tympan sheet."

Along the lower edge of the platen, and also at one side, are fastened "guides" against which the paper is fed. Accurate feeding against these guides assures uniform accuracy of the position of the printed impression on each

sheet. This is essential in color work where successive impressions are to be printed in register. There are also two metal blades called "grippers" which become pressed against the sheet as the press closes. The purpose of these grippers is to hold the paper firmly against the platen as it pulls away from the form when the press opens. Otherwise, the paper might stick to the form.

The inking rollers travel down and up, rolling against the form after each impression has been made, and at the end of each return trip they receive a fresh charge of ink from the distributing rollers. The main supply of ink is in a trough, called a "fountain," from which the distributing rollers receive a regulated supply for each impression.

Platen press printing requires an exceptionally level form. If it is low in any spots, these must be built up with thin sheets of paper pasted on the back of the form. This is called "underlaying." In addition, pressure may be equalized, or increased in some areas and lessened in others, by paper patches of varying thickness placed on the packing under the tympan sheet. These patches are called "overlays" and the whole operation is known as "make-ready." Overlays are sometimes just patches of paper, or they may be carefully cut to special shapes, or they may be "patent" overlays, made by any one of a number of different methods.

When hand fed, platen presses usually run at a speed not exceeding 1000 or 1200 impressions per hour. When automatic feeders are used, the speed can be materially increased.

Automatic feeders are ingenious machines which have suction cup "fingers" that pick up the sheets, one at a time, and feed them successively to position against the guides. Then they get out of the way in a hurry, as the

press closes. Other suction fingers remove the sheets after the impression has been made.

In planning a form layout for platen press printing, provision must be made for sufficient paper margin beyond and outside of the printing areas of the form, to permit the guides and grippers to operate properly.

Cylinder Presses

Cylinder presses have a flat bed for the form, but an impression cylinder takes the place of the platen. There are many variations in the cylinder press field, one of which will serve to explain the principle on which they operate.

These presses do not open and close like the platen press. The bed and its form move forward and back in a reciprocating motion. The cylinder is mounted on fixed bearings and rotates forward. The speed of the moving bed and the surface of the rotating cylinder are perfectly synchronized, and the press adjustment is so precise that, as the moving form slides under the rotating cylinder and comes into contact with it, a rolling printed impression of the entire form is made on the sheet of paper carried by the cylinder.

After the impression cylinder has made one complete rotation it is lifted or "tripped" by the press mechanism, to permit the bed to return to its starting position. While this return motion is taking place, the cylinder turns over again and delivers the printed sheet. Then the tripping mechanism lets the cylinder down again and it is ready to receive the bed and its form, to make another impression.

There are other types of cylinder presses in which the bed is vertical and moves up and down reciprocally, but

the basic principles of these presses are the same as the others, namely, a flat bed and flat form, with an impression cylinder to carry the paper.

Cylinder presses can be fed by hand or automatic feeders, and the "guides" lead the paper directly to the impression cylinder, which has automatically operated "grippers" which grab and hold the sheet as the cylinder turns. They let go when the impression has been made and release the sheet to be carried to the delivery pile.

Inking on cylinder presses of the reciprocating bed type is accomplished by the form passing forward and back underneath and in contact with the inking rollers. These rollers become recharged with ink after each impression, by making contact with an ink table attached to the moving bed. The ink table gets recharged from the ink trough or "fountain" each time the bed reaches its far-end position.

The make-up of the forms for any flat bed letterpress printing are sometimes extremely complicated. This method of printing permits the assembly of a great variety of material, such as hand or machine set type, blocked electrotypes and blocked plates made by the photoengraving or other processes.

These separate elements must be locked up in a chase so perfectly that the whole form can be lifted intact from the imposing table on which it was assembled, and transferred to the bed of the press. Sometimes the forms are so involved that they are imposed and locked up directly on the press bed.

Some idea of how complex and detailed a form may be can be gathered from the fact that a 64-page form of pages measuring 5″ x 8″, set in 8-point type, either hand composition or monotype, may comprise over a hundred thousand separate characters.

In a case such as this, unless the edition is to be relatively small, it is good practice to make beveled electros of each of the separate pages and mount them on patent bases.

Patent bases are specially made sectional steel blocks, accurately machined and equipped with "hooks" to fasten the beveled plates in position. The separate blocks can be assembled in practically any desired arrangement and size. These bases take the place of wood or other blocks and require plates 11 points thick.

Make-ready, consisting of both underlays and overlays, can be used on any type of flat bed press, but when the forms comprise a great variety of material, such as type and blocked plates, the amount of make-ready may well be very great and costly. This is especially true when the wood blocks of the plates are not all of the same "age" and thickness. Wood blocks dry out and shrink; sometimes they warp, and, if they have been exposed to excessive dampness or moisture, they may swell. A form of metal bases will obviate this trouble and there will be an additional advantage from the use of beveled electrotypes on them, because each plate will have been previously leveled and shaved accurately to the standard thickness of 11 points.

Another phase of make-ready is afforded by the use of specially made plates in which the shadow areas are slightly higher than those of the lighter tones. This provides the additional pressure on the heavy areas, and reduces the squeeze on the lighter tones.

Delivery of the printed sheets to the "delivery pile" can be either face up or face down, according to the mechanical arrangement of the delivery apparatus, but, as the sheets pile up, some of the wet ink on a freshly printed sheet is liable to be transferred to the next one.

This is called "offsetting." There are many ways of avoiding it. Slip sheets of plain manila paper can be placed between the printed sheets as they come from the press; the printed sheets can be passed over a gas flame on their way to the delivery pile to hasten ink setting; or if they are delivered face up they can be sprayed with a paraffin or starch solution. There are also some ingenious methods, utilizing both heat and cold, to set the ink after each impression so it will not offset.

The printing speed of any flat bed press is limited either by the time required to open and close it, or by the forward and back motion of the bed. Add to this the mechanics of feeding and removing the individual sheets, and the result is that some 5000 impressions per hour is about top speed for presses of this type.

Rotary Presses

Rotary presses require curved plates, either electros or stereos, which must be clamped to the plate cylinders. These plate cylinders, with their curved plates in position, rotate against the inking rollers and then against the "impression" cylinders. The paper is fed between these two rolls. As there is no opening and closing or reciprocating motion, and as the cylinders each rotate continuously, these presses can be driven at high speed; sometimes as high as 30,000 impressions per hour.

Rotary presses can be sheet-fed, but this limits the speed to the mechanical possibilities of the feeding mechanism. The paper for high-speed rotary presswork is fed into the press from a roll or "web," as a continuous band or ribbon. As it passes through the press, between each plate and impression cylinder, it acquires a series of repeated impressions of the plates on the printing cylinder;

a fresh one for each complete turn of the cylinder. This, of course, develops the problem of what to do with the web after it has been so printed, because so far the printing is only on one side of the paper. So these presses are designed to carry another pair of plate and impression cylinders which will print on the reverse side of the web before it leaves the press. When this double-printing operation has been completed, the printed web is slit, cut, and folded into signatures, before it reaches the delivery end of the press.

Some of these giant rotaries can turn out 30,000 64-page newspapers, or 128 magazine pages, per hour; all printed on both sides of the paper, cut, folded and ready for the newsstands or the magazine bindery.

The machines which print on both sides of the paper before it leaves the press are known as "perfecting" presses.

There are also certain types of web-fed presses on which the printed web is wound on a roll at the delivery end. It must be re-wound or un-wound for any subsequent operations.

The possibility of offsetting on high-speed perfecting presses is taken care of in various ways. Newspaper printing utilizes extremely fluid ink, and the paper is relatively porous. The ink penetrates into the paper, where it dries, without striking through. On other papers, heat drying is employed.

Make-ready with elaborate underlays or overlays are luxuries for which these high-speed rotaries cannot provide. Their emphasis is on the best printing quality, under the required operating speed. Provision for accentuation of values in lights and shadows in the pictorial results must be taken care of in the way the printing plates are made. "Pre-make-ready" or "bumped-up" plates

are valuable adjuncts to the processes of high-speed rotary letterpress printing.

Color Printing by Letterpress

Color printing by the letterpress processes must observe all of the technical requirements of single color printing, multiplied by the number of colors to be printed, and the way they are to be piled up on top of each other on the printed sheets; it can be divided into two general groups.

First: In which *none* of the colors are printed on top of other colors, previously printed.

Second: In which one or more colors *are* printed on top of others which have been previously printed.

An extremely important factor in this second group is: whether each added color is to be printed on top of previously run colors *after* they are *dry* or while these underlying colors are *still wet*. There are technical considerations which must be recognized and provided for, in the way the plates are made for the so-called "wet printing" processes.

Color printing requires a separate plate or a separate form for each color to be printed. For example:

We have a form of 16 pages of a book, of which the title page is one. Should it be desirable to print some parts of the title page in red, and the remainder in black, the black form would be made up with the red elements left out of it. After the black had been run, a separate form containing the red parts of the title would be printed, as a second impression, in the blank spaces left for this second color when the black form was run.

This same procedure would be followed for any other parts of the pages which were to be run in red instead

of black, and, obviously, the printing of a second color by this method requires double the number of impressions which would be needed if the form was run in black only.

But there are certain conditions under which more than one color can be printed at a time.

Assuming that the form is the same arrangement of 16 pages as described in the preceding paragraphs, it may be that while parts of the title page are to be printed in red, some other elements, such as headings in other parts of the form, are to be run in blue.

If the arrangement of the pages in the form permits, all of the red elements can be placed in one side of the form and all of the blue ones in the other.

The inking rollers are then cut to provide a wide groove, separating one-half of each roller from the other. The ink fountain is also divided with a dam to provide two separate troughs for the ink. One side is then filled with red ink and the other with blue. When the form is inked by the divided rollers, two different colors can be printed in one impression.

It is essential to note that this "split fountain" trick will work only in the straight lines following the direction of inking, and that there must be a space of about 2″ or more separating the color elements in each line. This spacing is necessary to avoid color mixing as the inking rollers vibrate from side to side.

If the rollers are not split, the colors will mix where they meet, and this condition is sometimes used to get "prismatic" or "rainbow" colors. Yellow on one-half of the fountain and blue on the other will blend into a gradually shaded green in the center. By using a flat tint plate for a background printing, some very interesting effects can be obtained.

There are special presses made for this split-fountain printing which can handle more than a dozen colors at a time with less than an inch of space separating them sideways.

There are presses which print two separate colors in what amounts to one impression, but these presses have two separate beds and two impression cylinders. The paper is picked up by the grippers on the first cylinder and printed by the first form. Then the sheet is taken over by an intermediate or transfer cylinder and moved on to the second impression cylinder. Then the second color impression takes place and the two-color sheet goes to the delivery pile.

Actually, these presses are two machines in one, and as separate forms are used for each color, the color elements can be placed in any desired position.

Split fountains can also be used, but this method destroys a complete set of inking rollers and it cannot be used economically on small runs.

When separate colors are to be printed one on top of another, the technical conditions become changed.

One method is to let the colors dry which are printed first; then the next color can be printed on them, but this cannot be done on a two-color press.

Usually, the reason for superimposing colors is to produce others, as when blue is printed on top of yellow to obtain green. When this is done, the second color run should be a transparent ink, otherwise it will impair the brilliancy of the underlying color.

Allowing one color to dry before adding another is called "dry printing" to distinguish it from the more complex method of printing successive colors on top of those which have been previously run and which are still wet. This is called "wet printing."

Wet printing requires specially prepared inks and printing plates. A complete story of the ink and plate characteristics would make a textbook in itself, but briefly, and purposely avoiding dangerous technical descriptions, the inks used for wet printing must vary in their density and stickiness, or "tack."

The first color down can be dense and tacky, but the next one must be less so. The tackiness of the first color causes it to stick to the paper, but its adhesive qualities are limited as it is still wet when the second color falls on it. If this second color has more tack than it should have, it may pull some of the first color off the paper. This stolen color will stick to the plate from which the second color is to be printed and eventually it might work all the way back to the ink fountain. But a properly reduced tack and density will cause the second color to leave its plate and lay properly on the wet ink of the first color down.

This scheme applies to all succeeding colors, and when it works properly the inks are said to "trap."

In so far as the plates themselves are concerned, they must be made so that solid or very heavy color areas do not print on equally heavy areas of previously printed plates. If a second color must of necessity be heavy, then the first one down must be sufficiently reduced in density when the plates are made, so as to leave as much "white paper" as possible for the heavy second color to stick to.

Wet printing is a highly developed art, requiring special presses as well as special plates and inks. It is extensively employed by publications which print quantities of four-color process plates in their editorial and advertising pages.

The method has been developed and perfected because of the need for producing huge edition quantities

in an incredibly short time, so the presses are nearly all of the high-speed rotary type, printing from curved electros.

Some multicolor presses using the sheet feed, as well as the web, have one huge impression cylinder surrounded by four and often five plate cylinders touching it at equidistant points. Each plate cylinder has its own inking rollers and ink fountains, and as the central impression cylinder makes one complete turn, the paper comes in contact, successively, with each of the inked forms on the plate cylinders. The printing speed of these multicolor rotaries is around 5000 copies per hour.

It is not possible to use make-ready overlays on these machines because the impression cylinder in the center receives at the same place the printed images from separate plate cylinders, each of which carries a different form.

Web-fed presses, which are the real high-speed machines of the industry, have one plate cylinder and one impression cylinder for each color form. They print from four to six colors on each side of the paper, and then cut and fold the web into signatures. They can be run at a printing speed of more than 12,000 completely printed and folded signatures per hour.

Ink drying or "setting" is accomplished in many different ways, but the principle most used is heat.

Presses for printing "aniline" colors belong to the letterpress group. Most of them print from rubber plates on cylinders of comparatively small diameter, and as they require relatively little printing pressure the presses are of lighter construction than the ones which use metallic relief plates in large sized forms.

Aniline printing can be done on many porous or fibrous materials such as paper bag stock and cartons,

and the ink dries almost instantaneously. With a modified type of pigmented ink a great deal of so-called "aniline" printing is done on cellophane and other synthetic materials.

The presses are web-fed, print as many as four colors in quick succession, and as the ink sets so quickly, the printed stock can be wound on a roll at the delivery end of the press, or fed directly into converting machines for bagmaking or other processing.

Etched zinc plates are used as patterns for moulding the final rubber plates, which can be fastened to the small printing rolls with adhesives. Some aniline printers also used wood rolls and a comparatively recent development is to use etched steel rolls, which are intaglio and printed with a rubber doctor blade.

Chapter XIV

Presses and Printing

Lithography

XIV

Presses and Printing, Lithography

Many lithographic presses are similar in principle to those used for letterpress, except that all of them must be equipped with the added mechanism for dampening the form with water moisture.

The presses which print from the big lithographic stones are invariably of the flat bed cylinder type. The stones may be as large as 38″ x 52″ in area and from 2″ to 4″ thick. The flat bed of the press is adjustable, to take care of stones of different thicknesses.

After a stone has been used, the surface can be ground off and used again for another job. This, of course, reduces the stone thickness and after repeated grindings it may become too thin, in which case it can be backed up with a slab of slate.

The image to be printed can be hand drawn or painted in, directly on the polished stone surface, using litho grease crayons or other suitable material; or the image can be applied by handwork, Ben Day tints or photography to a separate smaller stone and then transferred to the final printing surface. This latter method is used when a number of small elements like cigar bands and labels are to be duplicated in considerable number. This is one of the lithographer's methods of duplicating images, which in letterpress is achieved by electrotyping or stereotyping.

The granular structure of the stone provides the "grain" necessary to obtain tonal variations and, in effect,

it acts like the screen dot formation used in letterpress and photolithography. As this grain is "unsymmetrical" it does not pattern like the halftone screen when one color is printed on top of another. This makes it possible to use any number of colors required to do the job. The famous Currier and Ives prints are typical of this old litho stone technique and despite its antiquity it is still in use.

All other litho presses are of the rotary type and print from thin zinc or aluminum plates. These plates can be made by the albumin print process or the deep etch. They can be printed directly on the paper or by rubber blanket offset. They can be hand drawn like a litho stone or made by the photographic process, or both.

Rotary litho presses range in size from an "office" machine, which uses a plate only a little larger than a business letterhead, to the big ones that can handle a sheet 50″ x 72″.

The albumin print method is lithography in its simplest form. The printing area is a thin film of litho ink which adheres to the sensitized surface of the metal as a result of exposure to light through a photographic negative. This part of the process is quite similar to the making of an ink print for letterpress photoengraving. This thin litho print has certain limitations, respecting the amount of ink that it will accept for printing purposes.

The non-printing areas of the plate are protected by another thin film, but here it is gum and water moisture which has no affinity for the grease ink, and consequently rejects it when in contact with the inking rollers. These non-printing areas of a litho plate are not lowered as in letterpress plates. They are on the same level as the areas which will print and they come into contact with

the inking rollers in precisely the same manner as do the printing areas. That is why they must be made "ink-repellent" by the use of the gum and water.

Both line and halftone negatives can be used to make the print on the metal sheet, and these can be supplemented by handwork or Ben Day.

After the ink print has been developed the plate is given a slight acid bite to make the non-printing areas more receptive to the gum and water. It is not to deepen the plate as is done for letterpress printing.

After completion, and possibly the pulling of trial proofs on a litho proof press, the plate is wrapped around the plate cylinder of the press and clamped tightly in position. Relatively little make-ready is needed, as the plate has no high areas or low spots which need to be leveled up or given a greater or lesser amount of local impression for printing.

The paper used for this kind of lithographic printing is relatively smooth and somewhat soft. It must be specially prepared so it will work in harmony with the peculiar combination of ink, grease and water moisture used on the printing plates.

As metal sheets used in lithography are first grained, it is often possible to utilize this grain for tonal variations in much the same way that the grain of the litho stone can be used. This method would not require any albumin print nor supplementary halftone screen. The image to be printed would be hand drawn with litho crayon or "tusche," either directly on the metal or on special paper for subsequent transfer to the final metal plate.

Printing can be done in one or more colors on single color presses and these can be sheet or web-fed. Some of these presses are of the perfecting type and are used for turning out lithographically printed newspapers.

When photolithography first adopted the halftone screen for the reproduction of tone copies, the results, as compared with letterpress halftones on coated paper, left something to be desired. Lithography had one advantage; it was not necessary to use a coarse screen when printing on the soft litho paper, and despite the relatively greater brilliancy of the letterpress halftones, the need for a coarser screen when using other than coated papers left the field open for some workable method whereby fine screen halftones could be printed on antique finish paper.

Then came the offset process with its rubber blanket method of printing. This made it possible to print fine screen halftones on almost any surface, but the printed results still lacked the richness of letterpress. The deep-etch process which followed was a big improvement, both in black and white and color work. Two-color and four-color web and sheet-fed rotary offset presses were developed and the four-color process of reproduction became as much of a standard product for lithographers as it was for those in the letterpress field.

The depth of etch in the deep-etch process is very slight; sometimes only a fraction of .001″, but it is sufficient to give the impression the added brilliancy which it had lacked.

The plates can be chromium plated to give them longer life and the press speeds have been stepped up to more than 5000 impressions per hour. Although the offset process was invented primarily for use on antique paper, it is now used extensively on other surfaces, including specially prepared coated stock.

Single color offset presses have one cylinder to which the printing plate is fastened. The inking and water rollers are in constant contact with this cylinder. The

cylinder on which the rubber blanket is stretched makes contact with the plate cylinder at a point just beyond that of the inking and dampening rollers. The blanket has a surface hardness about like the tread of an automobile tire, but at the same time it is sufficiently yielding to conform, under printing pressure, to the uneven surface of the paper.

The third, or impression cylinder, squeezes against the blanket with just enough pressure to make the rubber, and its printed impression, touch all of the hills and valleys of the paper which is fed between these two. There may also be a fourth cylinder, used to deliver the printed sheets.

A two-color press would have twice this set-up of cylinders and a four-color press would have a minimum of twelve cylinders, not counting those required to transfer the paper from one group to another, and finally to make the delivery of the finished sheets. Single color presses are simple enough in principle, but the complications of the big four, five and six-color rotaries are, to put it mildly, rather dazzling.

Because of the relative simplicity of litho platemaking, it is used extensively to "blow up" letterpress halftones, in one or more colors, for posters and window displays.

This method requires a completely finished halftone or set of color plates. From these, single reproduction proofs must be made from each plate, using the best possible grade of coated paper, dense black ink and absolute cleanliness of the printed impression. There must be no weak dots anywhere, nor any filling up in the middle tones and shadows.

The lithographer photographs these reproduction proofs by the line negative process, enlarging them to the required overall size. The separate negatives are

then printed on the litho metal and printed in the separate colors required for each plate, registering the colors one on top of another, just as in letterpress printing or in color lithography. In color work, a set of letterpress progressive proofs should be supplied, so the lithographer will be guided in printing each separate color.

Enlargements from any letterpress halftones will change the screen fineness. A color set of 120-line screen enlarged four times will end up as a 30 screen reproduction, but as the enlarged prints are seldom viewed close up, the coarseness of the enlarged screen is seldom objectionable.

It is perhaps well to mention the fact that in speaking of enlarging a subject four times, or any other number of times, it is taken to mean "linear" enlargement, as when blowing up a subject that is 4″ wide, to make it into a poster or display 16″ wide.

The technique for the preparation of copy for lithography follows the same general rules that apply to the letterpress process, but if there is any difference, it is in the need for greater cleanliness of copy for lithographic purposes. These plates are not etched or routed and any imperfections which are due to the copy must be worked out of the negatives or positives by hand, or by additional handwork on the plates themselves.

Another feature which should be mentioned is that letterpress plates can be made singly and assembled in a form. Even after the form goes to press, certain changes can be made. A plate can be lifted and another substituted; plate positions can be changed; text can be corrected.

In lithography, the whole assembly of negatives and positives is done by stripping them together before they are printed on the metal sheet. When this becomes a

litho plate, the entire assembly is on one sheet of metal. A change *then* may mean remaking the whole plate.

Care in planning, and the preparation of a precision layout for the lithographer to follow, may save a lot of time and money.

Collotype or Photogelatin Printing

Closely related to the lithographic processes, but differing from them in many respects, is the collotype, or photogelatin process. Originally, it was done from gelatin-covered glass plates and was called "lichtdruk." Metal plates are now in general use.

The metal plate is coated with a specially sensitized film of gelatin, and this is printed from a screenless or continuous tone negative. The action of light, which is strongest through the transparent areas of the negative and less so through the denser parts, results in the creation of varying degrees of hardness in the gelatin film.

Development consists of soaking the printed film in water to an extent that makes it swell. As it is held securely in place by adhesion to the metal, the swelling tends to cause the surface to wrinkle into tiny grain-like particles. This is called "reticulation," and it serves to permit the printing of tonal variations like the litho grain or the halftone screen. Sometimes this is called a "screenless" process, because no supplementary screen is used either in making the negatives or the prints. But it has the equivalent of a screen in the form of the granular reticulations, else there would be no tone variations in the print.

Printing is done in about the same manner as regular lithography, but with no water roller. Glycerine is used in place of the gum, and the required water moisture is

taken from the air. The variations in the relative degrees of hardness of different areas cause the film to accept more or less glycerine; this in turn controls the amount of ink accepted and printed.

Photogelatin plates can be made in large sizes and are good for fairly long runs. They are used for printing in one or more colors.

Chapter XV

Presses and Printing

Gravure, Including Steel and Copperplate Work

XV

Presses and Printing, Gravure

Gravure presses are all rotaries. They have a plate cylinder and an impression cylinder for each color, and the contact between these cylinders creates a heavy printing pressure. Consequently, the presses are of very heavy construction.

The printing form can be etched into a thin copper plate or into the surface of a copper-covered cylinder. When the thin plate method is used, the plate must be wrapped around the plate cylinder of the press and clamped tightly in position, in somewhat the same manner as in offset plate printing.

When the etching is done on the surface of the copper-covered cylinder, the whole heavy mass must be handled during the etching process and then transferred to the press as though it were a part of the machine itself.

As in the litho processes, all assembling is done with the negatives and positives before the plates or cylinders are ready to be etched. And also, as in lithography, the gravure printer requires a precision layout for his guidance.

The depth of the etch in gravure is greater than that of the deep-etch offset. There is a rubber blanket on the impression cylinder which, with the considerable pressure afforded by the press, tends to force the paper into the etched cells of the plate.

Every plate cylinder in a gravure press has its own ink fountain and doctor blade. The plate cylinder rotates

with a small segment of its circumference dipped into a very fluid ink in the fountain directly below it. In addition there may be pressure nozzles to help force the ink into the cells of the plate. Some presses use a very volatile ink and the ink fountains are closed to prevent evaporation.

The doctor blade makes contact with the full width of the plate cylinder, directly above the ink fountain. As the cylinder turns against this blade, the excess ink which is scraped off falls back into the ink fountain, leaving just the right amount in each plate cell to make the proper printed impression.

These presses can be sheet or web-fed, the paper passing between the plate and impression cylinders like a flat piece of cloth going through a wringer. In sheet-fed presses, delivery can be made by another cylinder or by any other mechanical device which will handle the paper properly. Sheet feeding is done with mechanical feeders.

If the press is web-fed, the web can be cut and folded before it leaves the press, but this is on perfecting presses which print on both sides of the paper.

Color gravure can be done on single color presses, running but one color at a time, or on three and four-color presses. When sheet-fed, the multicolor presses print on but one side of the sheet at a time, but the web presses can print both sides.

Gravure ink is a liquid and has a very volatile body. It sets quickly, but the color presses have heat drying units between the different color cylinders to help speed drying. This is particularly necessary in the web-fed machines as they run at high speed and the impression on one side of the paper must be dry before the impressions are made on the other side.

Gravure plates and cylinders can also be chrome-plated which adds materially to the possible length of the run without noticeable wear on the plates.

Printing by gravure can be done on almost any material which will accept the ink, stand the pressure, and is sufficiently pliable to permit being forced into the plates but the ink may need to be specially made for the selected material. Paper which is hard and brittle, or which has hard lumps in it, may ruin the plate surface in a very few impressions. The surface of a gravure plate must be so smooth and perfect that all excess ink received from the fountain will be completely cleaned off by the doctor blade before the impression is made. The slightest dent or depression in the surface which does not belong there will leave a spot or a comet-like streak when printed.

In letterpress, because the plates can be made singly and assembled in forms later, it is possible to pull preliminary proofs before they are run.

In lithography, there are proof presses which can be used under certain conditions. In this process there is no need for any more printing pressure than will be required to cause the blanket to make complete contact with the paper.

In gravure, a proof requires just as much squeeze as the final run will call for, so the only way to find out what the etched plate has, so far as it concerns printing quality, is to put it on a press big enough to take the whole etched plate or cylinder.

The exception to this is in making positives for the News-Dultgen process for four-color printing.

The requirements for color, in publications using the Dultgen process of gravure printing, especially in advertising pages, have made it necessary to pull preliminary

proofs of the separate advertising color pages. This need has developed from the fact that the same color subject may be scheduled to run in more than one publication, and obviously all of them should look alike, regardless of where they are printed.

So the gravure platemakers licensed to use Dultgen make preliminary plates and proof them on small hand-fed proof presses which have been developed for this specific purpose. Corrections, if required, can be made in the negatives or positives and new proofs made from new plates. When the finished result has been approved, and the required number of progressive proofs have been pulled, then as many Dultgen positives are made as are needed by the separate publications scheduled to run the advertisements.

The final printers of the subject then make their own press plates, using the positives supplied, and they follow the progressives which accompany them to show what will be expected in the final run.

Steel and Copper Plate Printing

Plates in this group are intaglio and require surface wiping after each inking, but the methods vary considerably from the gravure processes, which use a doctor blade for the clean-off.

Steel engraving is used extensively for printing stock certificates, bonds, postage stamps and paper money. The plates are hand-engraved or cut by geometric lathes. When used for relatively small runs they can be flat, and hand-wiped. They can be heated to facilitate both inking and wiping and the paper can be dampened to make it easier to force it into the plates.

Postage stamps, paper money, or any other products

which are made in large quantities, are usually printed from steel cylinders which are mechanically wiped by means of a moving web of special paper.

Copper plate printing is usually confined to small runs such as visiting cards, wedding invitations and announcements. The plates are warmed for inking, wiped manually and printed with considerable pressure, usually on dry stock.

Steel die printing differs from both the steel and copper plate methods. The dies are usually about ½″ thick, quite deeply engraved, and after inking and wiping, the impression is made by forcing the paper into the inked die, in a special type of press.

Chapter XVI

Paper

The technical details relating to the production of pulp and paper, as described in this chapter, are from various publications issued by the S. D. Warren Paper Company and The International Paper Company. They are offered here by permission of these two paper manufacturers.

XVI

Paper

Most of the paper used for commercial printing is made from wood fibres and water.

The fundamental difference between one kind of wood pulp paper and another depends largely upon the way in which the wood is reduced to fibres, and the way these are treated before they are spread out in a thin film, dried and ironed.

When these operations have been completed, the result is paper.

Scientists have demonstrated that any fibrous vegetation can be made into paper of one sort or another. But the modern paper maker depends upon trees, because the forests represent a constant and uniform supply, the year round. Scientific, planned reforestation, by planting seedlings to replace the trees which have been cut, assures a continuance of the basic supply of wood.

The woods most used for making paper pulp are fast-growing trees of two classes. The straight conifers (or evergreens), such as spruce, pine and hemlock, produce one character of fibres. The leaf-shedding (or deciduous) trees—poplar, beech, birch and maple—are used to produce another character of fibre. After the bark, knots and other defects have been removed, and the logs cut to convenient lengths, the processes for reducing the wood to fibres consist either of "grinding" or "cooking." The method used establishes the kind of pulp, which in turn

has a definite relation to the kind of paper which will be produced.

Ground wood produces "mechanical wood pulp." In this process the logs are ground in a special machine, until reduced to tiny particles much like very fine sawdust. These fine particles are mixed with water and some "cooked" pulp and flowed onto the woven wire screen of the paper making machine where they form a web of paper. When this is properly pressed and dried it is "newsprint."

In the ground wood process the whole log is converted into pulp, so it will contain not only wood fibres, but also the fugitive gums and resins present in trees. These elements cause discoloration, weakening and ultimate disintegration of the paper, unless they are removed or neutralized by other special processes.

Cooking produces "chemical wood pulp." This process removes gums and resins and other fugitive material, so the pulp is pure fibre, but the process delivers only about half as much pulp as the ground wood process would deliver from the same logs.

There are several chemical processes used. The cooking can be done in hot solutions of caustic soda, sulphite (lime and sulphurous acid) and sulphate (caustic soda and sulphur). The methods to be used are determined by the kind of wood and the length and nature of the fibres which are required.

The ground wood and the caustic soda processes produce short fibres. Sulphite and sulphate pulp fibres are long.

Short pulp fibre gives paper the smoothness required for good printing; long fibres give strength. One of the great arts in papermaking is to properly combine both long and short fibre pulps.

Paper can also be made from "old paper" pulp. The used paper is cooked in chemicals which dissolve the printing ink and reduce the old papers back to pulp again. "Old paper" fibres are short and give paper smoothness, but must be combined with long fibres so that the paper may have strength.

Rags, consisting of vegetable fibres such as cotton or flax, can be made into very fine bonds, book and cover papers, if the rags are suitable. Colored rags, or those that have been subjected to much wear and laundering, do not make a first quality rag pulp. Mixtures of wood and rag pulps give what are called "rag content" papers.

In addition to the materials used, and the manner in which they are reduced to their basic fibres, the final character of the pulp is developed during the process called "beating."

A beater is a big oval tub designed like a race track, and the fluid pulp, consisting of fibres and water, moves around the oval beater much as horses move around a track. At one side of the beater, extending from its center to the full width of the "track," is a cylindrical drum called a "beater roll." Each time the watery pulp comes around, it must pass under the drum which presses the pulp down and rubs it against the bed plate of the beater. The beater roll can be raised to let the pulp pass with little disturbance, or it can be lowered until it beats the fibres severely.

Two things happen during beating: the fibres are roughened and frayed, and, somewhat mysteriously, they produce a gelatinous substance which, with the roughening and fraying, helps the fibres to cling together and cohere. Variations in the position of the beater roll and the duration of the beating will produce many variations in the fibres, both as to their length and roughness,

and it will also affect the peculiar and little understood reaction which produces the important gelatinous substance.

With proper beating, and the "hydration" which stimulates the production of the gelatin-like adhesive agent, fibres can be made so cohesive that they can be formed into printable paper without the addition of other substances. But for certain purposes, sizing with a material such as resin, mixed with the pulp during the beating process, serves certain ends other than to make the fibres hold together.

Sizing can be used in book papers to make them somewhat repellent to dampness, which otherwise might cause the paper to wrinkle. Bond paper pulps are highly sized so that the finished paper will not be too absorbent and may be written on without danger of the writing ink feathering or blurring. Bonds, litho and offset papers may also be surface sized with a material like starch. This provides an outside binder that will hold the fibres down and, at the same time, hold the offset ink upon the surface of the paper so that the colors may retain their density and brilliance.

Loading materials can be added to the pulp during the beating, to smooth up English finish and super papers and to produce a better surface for halftone printing; also to provide a better affinity for the ink, to brighten the color of the paper, and to increase opacity.

There are several different kinds of loading materials, such as refined clay, calcium carbonate, titanium oxide, zinc sulphide and others, developed especially by the papermakers for this purpose.

Smoothing materials, somewhat similar to those used for loading, can be applied to the surface of the finished paper to fill in the irregularities of the surface. This is

called "coating" and it affords what is probably the best possible surface for fine halftone printing.

Papermaking is not a new art; it has been carried on for more than two thousand years. But until the end of the eighteenth century, the product was in the form of separate sheets.

Nicholar Louis Robert, the manager of a large paper mill in France, invented a machine for making paper in a continuous strip instead of single sheets. Two brothers, Henry and Sealy Fourdrinier, working in England, developed the Robert idea into a practical and workable machine. Since that time papermaking machines, based on the Robert principle, have been universally known as Fourdrinier machines.

When the beating process has been completed, the mixture is flowed into a huge vat or "pond" located at the feed or "wet end" of the Fourdrinier machine. From this pond the milky fluid (which is about 98% water) is permitted to flow onto an endless belt of closely woven wire mesh. The amount deposited on these wires controls the thickness of the finished paper. The wire screen travels slowly forward and is shaken rapidly from side to side. Gravity, shake and suction devices help to drain the water off, leaving a formed web of paper. From the wire screen this web (now about 65% water) is then fed to another endless belt of felt, on which it is passed between pressing rolls which smooth the paper and squeeze out more water. Then it passes over a number of heated drying rolls to the dry end of the machine.

If the paper is to be antique, English finish, or body stock for coated paper, it is considered completed at this stage and is wound on rolls. If it is to be smoothed more, or "super calendered," the English finish stock is run through another series of rolls which iron and polish

the paper, one side at a time. If the stock is to be coated, the rolls are set up on another machine where the coating is applied.

The variety of materials which can be used for coating is as great, or even greater, than those used for loading. As the purpose of coating is to fill in all surface irregularities, the material must be of a velvet smooth texture; it must have an affinity for ink, yet permit penetration, absorption and drying of the varnish in the ink. Starch, casein and latex are used as adhesives to bind the coating to the body stock.

Coating is done by flowing the coating mixture onto the web of body stock and then it is distributed as evenly as possible with a series of brushes on either one or both sides of the paper. The wet web is then carried on air blasts through a drying alley and progressively higher temperatures which hasten the drying.

The Warren Mill has developed an "air blade" coater, as well as other special devices and methods, to distribute the coating more evenly.

After coating and drying, the web is rewound on a roll and then calendered to a smooth, polished surface.

Fourdrinier machines are huge. Some of them will produce a continuous band of paper nearly 200″ wide. The machines themselves may be well over a couple of hundred feet long, depending upon the number of drying drums with which they are equipped.

After completion, the wide bands of paper can be cut into rolls of lesser width, or into single sheets of any required size within the limits of the machines.

Sizes and weights of paper are designated by giving the sheet size and its weight per ream of 500 sheets. A cover paper listed as 20 x 26-65 means that the sheets are 20″ x 26″ and that 500 of them weigh 65 pounds.

Book, magazine and catalogue papers generally come in "stock size" sheets measuring 22″ x 28″, 25″ x 38″, 28″ x 44″, 38″ x 50″, 44″ x 64″ and 50″ x 72″. If the quantity warrants, the mill will make them to order in any size.

The establishment of certain "standard" sizes of paper helps printers to determine how many and what sized page can be cut from any one of the standard sizes of stock available, because it may be that the edition to be printed would not be large enough to warrant a special sized sheet to be made.

Assuming that the printer hopes to be able to run some job in sixteen page forms, and that the tentative decision for the page size is 6″ x 9″, he will lay out a form with four pages across the sheet and four pages up and down. If the page is to be vertical, he will multiply the 6″ dimension by four and the 9″ also by four, and the answer will be 24″ x 36″. Obviously this sized form can be printed advantageously on a 25 x 38 sheet, allowing ample margins for grippers, guides, and trimming space between pages.

But it may be that the printer has a big press that will take a sheet 50″ x 72″ and wishes to run the largest form which that press will take. If 6″ x 9″ is still the desired page size he will divide 6″ into 50″. It will go eight times with a 2″ margin left. When dividing the 9″ into the 72″ however, while it will go eight times it leaves no margins for trim, grippers or guides. His dream of a 6″ x 9″ size in a sixty-four page form will be lost, because the 9″ divided into 72″ is too tight a fit. But by reducing the 9″ dimension to 8¾″ he can have his big sixty-four page form with gripper and trim margins both ways, because eight times 8¾″ equals only 70″.

Should the job be planned for bleed pages, the page

size would have to be still further reduced, as at least a quarter of an inch must be allowed on both dimensions of a page, to take care of bleed requirements.

When the weight per ream and the sheet size is known, it is often necessary to find out the equivalent weight in other sizes. If 500 sheets 25″ x 38″ weigh 80 pounds, the weight of 500 sheets 50″ x 72″ can be determined by reducing both sheet sizes to their square inch area and then working out the problem by proportion.

25″ x 38″ equals 950 square inches. 50″ x 72″ equals 3600 square inches. If the 25 x 38 basis is 80 pounds then the problem becomes 950:80-3600:x. So it will be found that 500 sheets 50″ x 72″ on an 80 pound basis, will weigh a little more than 303 pounds.

There are some trade terms and customs which are liable to cause confusion. One is specifying 1000 sheets to a ream rather than 500. In the case of a 25 x 38-80 paper, a ream of 1000 sheets would weigh 160 pounds, and would be expressed as 25 x 38-160M. Another is to refer to paper as 80 pound or 100 pound without also giving the sheet size. Custom has established the 25 x 38 sheet as a unit of standard, much as the pica is a standard of measurement in typography. So when a paper is said to be 100 pound, it means 25 x 38-100. But when a printer submits an estimate for a catalogue and specifies 100 pound stock for the inside and 65 pound for the cover, it would seem, at first glance, that the cover would be of a lighter weight than the inside. It does not work out that way, however, because reference to 65 pounds cover means that weight in cover stock sizes, such as 20 x 26-65. The equivalent weight of a 20 x 26-65 cover paper, as compared with a 25 x 38 sheet, would be nearly 116 pounds to the 500 sheet ream.

Bonds and letter papers are usually based on a sheet

size of 17 x 22. This size will cut exactly four 8½ x 11 business letterheads to a sheet. The reference then, to a 20 pound bond, means 17 x 22-20 or a 25 x 38 equivalent of nearly 50 pounds.

Form Layout

The production problems of big edition high-speed printing by any of the processes requires that as many single pages as possible be grouped and printed at one time. The layout for a big form and the assembly of a number of separate units is a critical job of "imposing" and requires much knowledge and experience.

Without going into a lot of involved and cumbersome descriptions of form layouts, a good general idea of the procedure can be gained by folding a large single sheet of paper into a "signature."

For demonstration purposes, select a sheet of paper 11 x 14 and lay it flat on a table with the 14″ dimension vertical. Fold the sheet from the top down and crease it at the fold. Then fold it again from right to left and crease again. The folded sheet will now be 5½ x 7.

Without unfolding the sheet, number each of the pages, beginning with #1 on the first outside page. The last page will be #8. This, then, is an "eight page signature."

Now open the folded sheet and lay it flat again and it will be seen that there are four pages on one side of the sheet numbered 5, 4, 8 and 1, counting from upper left to lower right. Turn the sheet over and the pages will be 3, 6, 2 and 7. Hold the sheet up to the light and page 1 will be "backed up" by page 2; 3 by 4, 5 by 6, and 7 by 8.

By folding the sheet again to its original form and giving it one more fold, it will have sixteen pages, but

each one of them will be half the size of those in the eight. If the sheet is renumbered after folding into a sixteen page signature and then laid out flat, the position of the separate pages on each side can be observed. There will be eight on each side of the paper.

This little experiment will serve to indicate some of the intricacies of form layout when imposing for thirty-two, sixty-four or even one hundred and twenty-eight page folding. It will also indicate why the paper selected for any signature must be larger when folded, than the final size of the finished page. When separate folded sheets are bound up into magazine or book form they must be trimmed. This cuts off the folded edges but at the same time reduces the size of the page.

In planning for "bleed" pages the actual plate size must be larger than the trimmed size, but smaller than the folded paper size. In the operation of trimming, a small margin of this excess size is trimmed off, causing the printed image to extend clear to the trimmed edge. Provision for the oversized plate area must be taken care of when planning the imposition of the form and the paper size must also be planned to permit this "bleed" finish on the printed pages. In letterpress, bleed pages cannot be produced by allowing a larger plate to "overhang" the edge of the paper when printing; paper size must allow for lock-up space between bleed edges in this process.

Chapter XVII

Ink

Ink Makes All of the
Printing Arts
Graphic

The technical features relating to ink and its uses, as described in this chapter, are from published manuals and descriptive articles supplied by the International Printing Ink Company. They are reprinted by permission.

XVII

Ink

In its earliest form, printer's ink was a boiled linseed oil varnish with suitable pigments mixed into it. When it dried after being printed, it left a film of pigment and varnish, well bonded to the surface of the paper. The permanence of good carbon black and linseed oil varnish as a printing ink is attested by the brilliance and legibility of book pages printed more than five hundred years ago.

For certain purposes, ink of this type is still used. Given sufficient time, printing with such ink dries by itself, but weather conditions and the characteristics of the paper or other material on which the printing is done makes drying time very uncertain. It may take hours or it may take days. This is a serious handicap to fast production, especially when the paper has to be printed on both sides.

This difficulty has been overcome by the use of synthetic vehicles to replace the oil varnishes. These new ingredients produce "heat set" inks. Heat vaporizes or ignites their volatile products, resulting in almost instantaneous drying.

From a laboratory standpoint, ink specifications are extremely complex and involved. The ink manufacturer must know what kind of printing is to be done. Will it be letterpress, lithography, gravure, aniline, steel die or copperplate?

When the printing process has been selected, the next

question concerns the kind of press to be used in the specified process.

Letterpress machines range from the slow-moving flat bed cylinder presses, through all of the different rotaries, and end up with the high-speed newspaper presses. For each type of press the ink must be made to suit.

Add to the press factors the vast array of papers: glassine, bond, parchment, coated, machine finish and super, in all of their different weights and finishes. Inks for coated papers are not suitable for machine finish; news ink, which dries by penetration into the newsprint paper, might take days or weeks to dry hard on either bond or glassine papers, where penetration is prevented by the very nature of the paper and its finish.

For lithography, the type of press must also be specified. The flat bed press using lithographic stones will require a different type of ink than the direct rotary. Offset presses require still another type, and the multicolor rotaries will again change the ink specifications. Even the rotation of colors in wet printing may need to be known to provide for proper trapping of the wet inks.

Materials on which lithographic printing is done include sheet metal. Offset printing on tin, for ultimate conversion into cans and containers, requires an ink which will withstand the high heat or oven-drying treatment and fabrication, without causing changes in colors or quality of the impression.

Gravure inks are used on many types of presses. The relatively slow-moving sheet-fed presses use a different ink from that required on the high-speed web-fed rotaries. Gravure is used for printing on some materials which are quite different from paper in their ink requirements. Among these are the "plastics" such as Pliofilm and the vinyls.

Aniline inks get their name from the earliest inks used in this process. They were aniline dyes dissolved in alcohol. One of the advantages in this kind of printing was the penetration of the dyes into porous papers and other materials and almost instantaneous drying. Aniline presses were hooked up directly to bagmaking and other conversion machinery so both the printing and converting became one continuous operation.

But this type of aniline ink gave little or no opacity or "body" on cellophane and other non-porous transparent materials. So pigmented inks were devised and are now in use to almost the complete exclusion of the regular anilines. Many of these provide for quick application of considerable heat which is necessary to bind them to the plastics on which they have been printed.

Steel die and copperplate inks must provide for easy surface wiping, possible heating, and use on dampened stock.

In addition to all of these things, there is an equally extensive list of special requirements which may apply to almost any one, or all of the printing processes. These include gloss, metallic, non-scratch and non-rub inks; rain and pasteproof inks for outdoor posters; inks for lacquered stocks and foils and the food wrapper inks.

Butter and oleomargarine wrappers require inks which will withstand contact with grease and yet will not "bleed" and color the contents of the package. Other inks must withstand rapid temperature changes from freezing to thawing and back to freezing again. And food wrapper inks must be odor free and in full observance of all food and drug legislation.

Colored inks have two generally different characteristics: they may be made "opaque" or "transparent."

Opaque inks are used on surfaces where coverage of

the underlying color of the material is necessary, such as when printing a solid yellow color on blue cover stock. Opaque inks do not work very successfully when it is desired to produce some other color by printing one ink on top of another, because the opacity and coverage of the last color down does not permit the color of the underlying ink to show through.

In multicolor printing, especially in process work using yellow, red, blue and black, the first color down is usually opaque or semi-opaque. The succeeding colors should be transparent to permit the underlying colors to show through, for in that way the production of other colors becomes possible. And it is well to bear in mind that the colors of transparent inks will be affected by the color of the underlying paper. A process color job printed on white paper will have a different color appearance if it is printed on paper that is not white.

Vehicles, binders, dryers and pigments must all be co-ordinated to suit the printing methods and the receiving materials. For certain purposes the colors of inks must be as permanent and light fast as it is possible to make them within commercial limitations.

And finally the inks must be so made that, regardless of the nature of the materials to be printed or the methods of application, they will "lay there and stay there" with the proper coverage, opacity or transparency, which the printing process requires.

Chapter XVIII

"Which is the Best Process?"

XVIII

"Which is the Best Process?"

The answer to this question is deeply hidden among the answers to a very long list of others.

Even the most experienced users of the processes must weigh and evaluate all of the controlling factors before they can arrive at a decision. These are such things as the kind of paper best suited to the production, the sizes of the forms that can be printed on these papers, the kind of printing plates and comparative costs by different manufacturing methods, the size of the edition, speed of presses, delivery time, overall production costs, shipping costs, quality of the printed product and its appropriateness of appearance, durability and availability to possible reprints, even considering possible construction changes in the manufactured products illustrated and described.

For example: The New York City telephone directory. The type matter in these books is being changed daily, perhaps hourly, and a new issue comes out every six months. Letterpress is obviously the logical process for such a book, simply because of the facility with which the listed names and numbers can be revised.

Another: Printing on tin for cans and containers. The rubber blanket of the offset process lends itself ideally to printing on the hard, unyielding metal.

These two, however, are among the easy problems.

The International Paper Company celebrated the fiftieth anniversary of its founding in 1948. It was decided

to issue a book, telling the Company's story, not only for the benefit of their customers, but as a souvenir of the occasion for its thousands of employees, through whose efforts the Company was enabled to successfully reach the half century mark of its life.

It was deemed fitting that one of the major products of the Company, Ticonderoga offset paper, should be used for the book. But it was to be profusely illustrated with photographs and charts, graphs and diagrams, many of them in color, and there was to be a considerable amount of text matter.

In keeping with the circumstances, Louis Ansbacher, the designer, decided on a page size of $10\frac{1}{4}$ x $13\frac{1}{2}$. Of the more than one hundred photographs many were printed to bleed and sheet-fed gravure was used to print them. The text matter was all printed by letterpress from vinylite mould steel-faced electrotypes. The charts and graphs were done by offset in seven colors. The end papers and the medallion for the center of the cloth cover were printed by color sheet-fed gravure.

The answer to the question of which is the best process was answered in this production by using all three.

Perhaps the way the question should be put, would be: "Which is the best process FOR THE PURPOSE."

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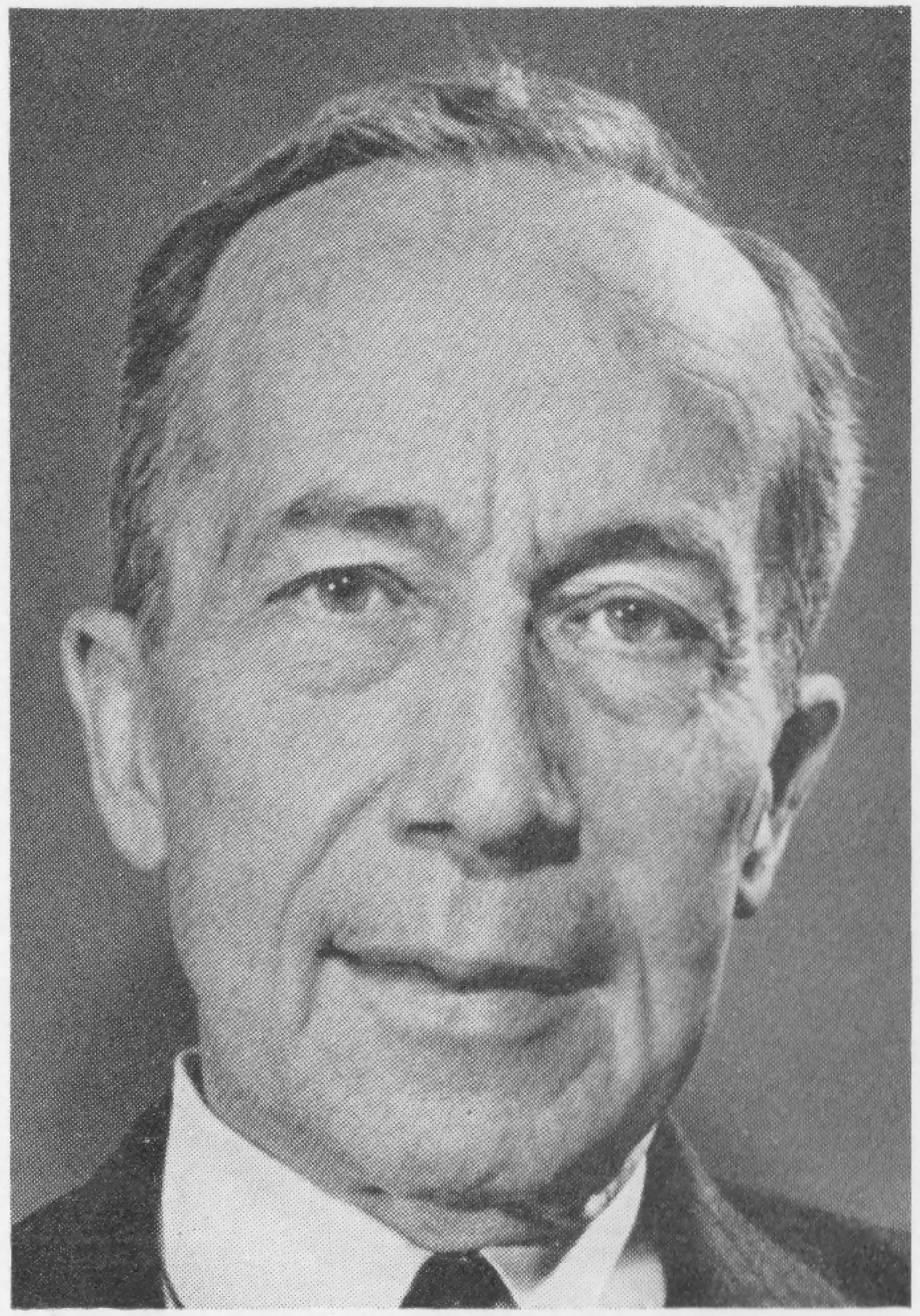
Harry Appleton Groesbeck, Jr.

1877 - 1950



Harry Appleton Groesbeck, Jr., was born December 12, 1877, in New York City, and died there June 15, 1950, in complete prostration because of the death of his greatly beloved wife, Pauline Lewis Groesbeck, who had passed on only the week before. They had been married for forty-nine years.

Harry Groesbeck was one of the great personalities who made real contributions to the graphic arts of this era. He was a noted technician of the photoengraving industry. In this field of effort he was a great interpreter. By speech or the written word he reduced the complex and the complicated to the simple and the real.

For over twenty-five years the writer has been an intimate of Harry — knew him as a salesman, an executive, an inventor, a writer, a speaker, an experimenter, a leader in advancing knowledge and in creating skills. Not once, until his wife needed his presence and devoted care, did he ever refuse an assignment that I or others wanted him to accept, if it would advance any phase of the graphic arts. He never considered himself first. He gave always his best to any effort, that best being without peer.

One of Harry's characteristics was to share knowledge — freely, anxiously, adequately. He was always eager to give, for the benefit of those searching for knowledge, all the know-how he had found out for himself through study and experimentation, and by the sweat of his brow. There was not a selfish bone in his body.

Absolute sincerity of purpose at whatever cost to him was one of Harry's guideposts. Effort — not mere inspiration — was his way of translating purpose into application; sweating blood; struggling; trying — and trying again. Concentration; stick-to-itiveness; "keeping everlastingly at it" until success was achieved. That was Harry. What would be drudgery to most was fun to him. At least, he made it fun. He never left undone anything which out of his experience and judgment should be done.

Harry was one of those rare persons who understood optics and chemicals and who had the ability to translate (as a kind of lay scientist) the complexities of science to other laymen. And, too, he could translate the needs of laymen to scientists with equal clarity. His writing was

clarity itself. All his expositions showed a developed sense of sincere showmanship.

He added dignity and prestige to the industry to which he gave most of himself. All who knew him or read his writings learned from him; came to believe in their craft and in themselves, and in the fact that profit is the by-product of work well done. Yes, he *did* things – worth-while things. His coat was off; his hands got dirty; but his heart and his mind were clothed with Purpose – and were clean.

Harry Groesbeck's life deserves the service of a real biographer. His personal principles, his professional effort on behalf of the Photoengraving Industry and his services to the graphic arts as a whole include very many vital lessons on how to live a useful life. Lessons on how to achieve fulfillment of worthy ideals, even in the midst of a material world, on how to be a Go-Giver even among a preponderance of Go-Getters. I lament my personal limitations as a biographer. Limitations that are accentuated because of the suddenness of his departure from this earth. The loss of great men is truly realized only when they have gone from us for a time and we learn there is no one who can take their places.

Harry's way of life was a good way. If he could read this tribute he would be the first to deny that the things I have written here were deserved by him – but he'd go on with renewed effort to deserve them. The greatest tribute to him that others who are still on the job can make is to achieve still higher standards – to "carry on" until such higher standards are established.

W. ARTHUR COLE, *Managing Director*
Photoengravers Board of Trade of New York, Inc.

June 27, 1950.